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INTRODUCTION TO COMMAND, CONTROL, AND COMMUNICATIONS: A PRIMER

by

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It supports course objectives by providing an executive overview of a wide variety of C2 topics. These topics include: C2 related definitions; roles, missions, capabilities, and warfighting philosophies of the military services; C2 functions and C4I systems used by the military services; and C4I modernization initiatives.

This primer serves as a daily reading source that explains fundamental concepts, highlights key points in external readings, and cites examples of modern applications of C4I systems. The thesis is not intended to eliminate the requirements for outside research from the courses, but only to reinforce the main ideas. The concise organization of material presented in this thesis will promote retention of the course objectives that will better prepare students for follow-on courses in the C3 curriculum.

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INTRODUCTION TO COMMAND, CONTROL, AND COMMUNICATIONS: A PRIMER

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This thesis is a primer for students in the Introduction to Command, Control, and Communication Courses at the Naval Postgraduate School. This document provides students a consolidated reference that emphasizes key concepts and ideas presented by the course instructor and required readings. Its organization closely parallels the course outline used for in-class instruction.

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TABLE OF CONTENTS

LIST OF ABBREVIATIONS AND ACRONYMS

AAW	Anti-air Warfare
AAWC	Anti-air Warfare Commander
ABCCC	Airborne Battlefield C2 Center
ABCS	Army Battle Command System
ACC	Air Combat Command
ACCS	Army Command and Control System
ACDS	Advanced Combat Direction System
ACE	Air Component Element
ACF	Air Contingency Forces
ACUS	Area Common User System
ADDS	Automated Digital Data System
ADS	Airspace Deconfliction System
AEW	Anti-electronic Warfare
AFAC	Airborne Forward Air Controller
AFATDS	Advanced Field Artillery Tactical Data System
AFMSS	Air Force Mission Support System
AFORMS	Air Force Operational Resource Management System
AOC	Air Operations Center
APS	Automated Planning System
ARCENT	Army Forces Central Command
AREC	Air Resource Element Coordinator
ASAS	All Source Analysis System
ASG	Area Support Group
ASOC	Air Support Operations Center
ASUW	Antisurface Warfare
ASW	Antisubmarine Warfare
ATACC	Advanced Tactical Air Command Central
ATCCS	Army Tactical Command and Control System
ATEAMS	Advances Tactical EA-6B Mission Support System
ATF	Amphibious Task Force
ATO	Air Tasking Order
ATODB	Air Tasking Order Database
AUTODIN	Automated Defense Information Network
AWACS	Airborne Warning and Control System
AWC	Air Warfare Commander
AWDS	Automated Weather Disseminating System
AWIS	Army WWMCCS Information System

B2C2	Battalion and Below Command and Control System
BFA	Battlefield Functional Area
BGLC	Battle Group Logistics Coordinator
C&D	Command and Decision
C2	Command and Control
C3	Command, Control, and Communications
C3DDS	Command, Control, and Communications Decision and Display System
C4I	Command, Control, Communications and Intelligence
C4IFTW	C4I For The Warrior
CAFMS	Computer Assisted Force Management System
CAFWSP	Combat Air Forces Weather Support Program
CAMS	Consolidated Aircraft Maintenance System
CARS/JSIPS	Contingency Airborne Reconnaissance System/Joint Service Imagery Processing System
CAS	Close Air Support
CAS-B	Combat Ammunition System-Base
CATF	Commander of the Amphibious Task Force
CCC	Command and Control Complex
CCG	Combat Communications Group
CCS	Combat Communications Squadron
CDR	Commander
CDS	Combat Direction System
CE	Command Element
CENTCOM	Central Command
CFL	Coordination Fire Line
CIA	Central Intelligence Agency
CIC	Command Information Center
CINC	Commander in Chief
CINCCENT	CINC Central
CINCEUR	CINC Europe
CINCFLT	CINC Fleets
CINCLANTFLT	CINC Atlantic Fleet
CINCNAVCENT	CINC Navy Central
CINCPAC	CINC Pacific
CINCPACFLT	CINC Pacific Fleet
CINCSOUTH	CINC South
CINCUSAFCENT	CINC U.S. Air Force Central
CINCUSAFE	CINC U.S. Air Force Europe
CINCUSACOM	CINC U.S. Atlantic Command

CINCUSNAVEUR	CINC U.S. Navy Europe
CIS	Combat Intelligence System
CJTF	Commander Joint Task Force
CLF	Commander of the Landing Force
CNCE	Communications Nodal Control Element
CNO	Chief of Naval Operations
CNR	Combat Net Radio
COC	Combat Operations Center
COE	Common Operating Environment
COMSECONDFLT	Commander Second Fleet
COMSEVENTHFLT	Commander Seventh Fleet
COMSIXTHFLT	Commander Sixth Fleet
COMTHIRDFLT	Commander Third Fleet
CONUS	Continental United States
COTS	Commercial off-the-shelf Software
CP	Command Post
CRC	Control and Reporting Center
CRP	Control and Reporting Post
CS	Constant Source (intelligence)
CSCE	Communications System Control Element
CSSCS	Combat Service Support Control System
CSSE	Combat Service Support Element
CSSOC	Combat Service Support Operations Center
CTAPS	Contingency TACS Air Planning System
CTE	Commander Task Element
CTF	Commander Task Force
CTG	Commander Task Group
CTU	Commander Task Unit
CUDIXS	Common User Digital Information Exchange System
CVBG	Carrier Vessel Battle Group
CWC	Composite Warfare Commander
DAMA	Demand Assigned Multiple Access
DART	Dynamic Analysis and Replanning Tool
DASC	Direct Air Support Center
DCS	Defense Communications System
DCTN	Defense Commercial Telecommunications Network
DDN	Defense Data Network
DISA	Defense Information System Agency
DISN	Defense Information System Network
DISNET	Defense Integrated Secure Network

DMS	Defense Message System
DNVT	Digital Non-Secure Voice Terminal
DoD	Department of Defense
DoT	Department of Transportation
DSCS	Defense Satellite Communications System
DSN	Defense Switched Network
DSNET	Defense Secure Net
DTG	Digital Trunk Group
EAC	Echelons Above Corps
ECB	Echelons Corps and Below
ECCM	Electronic Counter Countermeasure
EHF	Extremely High Frequency
ELINT	Electronic Intelligence
EPL	Emitter Parameter Listing
EPLRS	Enhanced Position Location Reporting System
EUCOM	European Command
EW	Electronic Warfare
EWC	Electronic Warfare Commander
FAAD	Forward Air Area Defense
FAADC2I	Forward Area Air Defense Command, Control and Intelligence
FACP	Forward Air Controller Post
FAPES	Force Augmentation Planning and Execution System
FDC	Fire Direction Center
FLTSAT	Fleet Satellite
FM	Frequency Modulated
FORSCOM	U.S. Army Forces Command
FOSIC	Fleet Ocean Surveillance Center
FOSIF	Fleet Ocean Surveillance Facilities
FOTC	Force over-the-horizon Tracking Coordinator
FSCL	Fire Support Coordination Line
GCCS	Global Command and Control System
GCE	Ground Command Element
GENSER	General Service
GLOBIXS	Global Information Exchange System
GMF TACSAT	Ground Mobile Forces Tactical Satellite
GOTS	Government off-the-shelf Software
GPS	Global Positioning System

HIC	High Intensity Conflict
HREC	Helicopter Resources Element Coordinator
IAS	Intelligence Analysis System
ICM	Intelligence Correlation Module
IDASC	Improved Direct Air Support Central
IDB	Integrated Database
IFF	Identification Friend or Foe
IHFR	Improved High Frequency Radio
IMDB	Imagery Management Database
IMOM	Improved Many-on-Many
JCS	Joint Chiefs of Staff
JFACC	Joint Forces Air Component Command
JFAST	Joint Flow and Analysis System for Transportation
JMCIS	Joint Maritime Command Information System
JMEM	Joint Munitions Effectiveness Manual
JOPES	Joint Operational Planning and Execution System
JOTS	Joint Operations Tactical System
JPEC	Joint Planning and Execution Community
JSIPS	Joint Services Imagery Processing System
JSOTF	Joint Special Operations Task Force
JSTARS	Joint Surveillance Target Attack Radar Set
JTF	Joint Task Force
JTIDS	Joint Tactical Information Distribution System
JUDI	Joint Universal Data Interpreter
JWICS	Joint Worldwide Intelligence Communication System
LAN	Local Area Network
LANTCOM	Atlantic Command
LDMX	Local Digital Message Exchange
LEASAT	Leased Satellite
LEN	Large Extension Node
LF	Low Frequency
LIC	Low Intensity Conflict
LOGMOD	Logistics Module
LOGSAFE	Logistics Sustainment Analysis and Feasibility Estimator
LOS	Line-of-Site
MAFATDS	Marine Advanced Field Artillery Tactical Data System
MAGTF	Marine Air Ground Task Force

MANPER	Manpower Personnel Module
MAOC	Mobile Air Operations Center
MAP	Master Attack Plan
MATCALS	Marine Air Traffic Control and Landing System
MCE	Modular Control Equipment
MCS	Maneuver Control System
MCSSCS	Marine Combat Service Support Control System
MCTCCS	Marine Corps Tactical Command and Control System
MEB	Marine Expeditionary Brigade
MEF	Marine Expeditionary Force
MEU SOC	Marine Expeditionary Units with Special Operating Capability
MEU	Marine Expeditionary Unit
MF	Medium Frequency
MIC	Medium Intensity Conflict
MIDS	Multifunction Information Distribution System
MILNET	Military Net
MILSTAR	Military Satellite Relay System
MLRS	Multiple Launch Rocket System
MMC	Material Management Command
MPS	Marine Prepositioning Ship
MRMS	Maintenance Resource Management System
MSE	Mobile Subscriber Equipment
MSGDB	Message Database
MSRT	Mobile Subscriber Radio Terminal
MULTICAST	Multicast Broadcast System
NALCOMIS	Navy Aviation Logistics Command Management Information System
NAVAIR	Naval Air
NAVAIRLANT	Naval Air Atlantic
NAVCOMPARS	Naval Communications Processing and Routing System
NAVMACS	Naval Automated Modulated Communication System
NAVSUB	Naval Submarine
NAVSUBLANT	Naval Submarine Atlantic
NAVSURF	Naval Surface
NAVSURFLANT	Naval Surface Atlantic
NC	Node Center
NCA	National Command Authority
NCCS-A	Naval Command and Control System-Ashore

NCTAMS	Naval Computer and Telecommunications Area Master Station
NCTC	Naval Computer and Telecommunications Command
NCTS	Naval Communications and Transmission Station
NEACP	National Emergency Airborne Command Post
NEF	Naval Expeditionary Force
NEO	Noncombatant Evacuation Operation
NERF	Naval Emitter Reference File
NFA	No Fire Area
NID	Naval Intelligence Database
NIEWS	Navy Imagery Electronic Warfare System
NIPRNET	Nonsecure Internet Protocol Router Network
NIPS	Naval Intelligence Processing System
NMCC	National Military Command Center
NMCS	National Military Command System
NME	National Military Establishment
NSC	National Security Council
NTCC	Naval Telecommunications Center
NTCS-A	Naval Tactical Command System-Afloat
NTCSS	Naval Tactical Command Support System
NTDS	Navy Tactical Data System
NTS	Navy Telecommunications System
OCAC	Operations Control and Analysis Center
OPINTEL	Operations Intelligence
OPS	Operations
OSD	Office of the Secretary of Defense
OSS	Operations Support System
OTC	Officers in Tactical Command
OTC/CWC	Officer in Tactical Command/Composite Warfare Commander
OTCIXS	Officer in Tactical Command Information Exchange System
PACOM	Pacific Command
PLRS	Position Location Reporting System
PSN	Packet Switched Node
PSS	Primary Ship-to-Shore
RAAP	Rapid Application of Air Power
RATT	Radioteletype System

RAU	Radio Access Units
REM	Route Evaluation Module
RFL	Restricted Fire Line
SAG	Surface Action Group
SATCOM	Satellite communication
SAU	Surface Action Unit
SCC	Signal Control Center
SCI	Special Intelligence Information
SEC	Submarine Element Coordinator
SECDEF	Secretary of Defense
SEN	Small Extension Node
SEW	Space and Electronic Warfare
SEWC	Space and Electronic Warfare Commander
SHF	Super High Frequency
SIDS	Secondary Imagery Distribution System
SIGINT	Signal Intelligence
SINCGARS	Single Channel Ground Air Radio System
SIPRNET	Secure Internet Protocol Router Network
SLOC	Sea Lines of Communication
SNAP	Shipboard Nontactical ADP Program
SOA	Special Operations Aviation
SOUTHCOM	Southern Command
SPF	Special Purpose Force
SQDN	Squadron
SSIXS	Submarine Satellite Information Exchange Subsystem
SSN/SSBN	Submarine (Nuclear)/ Submarine Ballistic (Nuclear)
SSS	Secondary Ship-to-Shore
STACCS	Standard Theater Army Command and Control System
STT	Shore Targeting Terminal
STW	Strike Warfare
STWC	Strike Warfare Commander
SUPCOM	Support Command
TACC	Tactical Air Command Center
TACFIRE	Tactical Fire System
TACINTEL	Tactical Intelligence System
TACP	Tactical Air Control Party
TACS	Theater Air Control System
TADIL	Tactical Digital Data Link Information

TADIXS	Tactical Data Information Exchange System
TAF	Tactical Air Force
TAMPS	Tactical Air Mission Planning System
TAOM	Tactical Air Operations Module
TBM	Theater Battle Management
TCAC	Technical Control and Analysis Center
TCC	Tactical Command Center
TCO	Tactical Combat Operations
TDA	Tactical Decision Aides
TIMS	Tactical Information Management System
TISD	Tactical Information Situation Display
TOC	Tactical Operation Center
TPVM	Target Plotting and Verification Module
TRANSCOM	Transportation Command
TRAP	Tactical Rescue of Aircraft and Personnel
TWCS	Tomahawk Weapons Control System
U.N.	United Nations
UHF	Ultra High Frequency
ULCS	Unit Level Circuit Switches
USARCENT	U.S. Army Central
USAREUR	U.S. Army Europe
USARLANT	U.S. Army Atlantic
USARPAC	U.S. Army Pacific
USARSO	U.S. Army South
VHF	Very High Frequency
VLF	Very Low Frequency
WAN	Wide Area Network
WCCS	Wing Command and Control System
WIN	WWMCCS Intercomputer Network
WOC	Wing Operation Center
WWMCCS	World-Wide Military Command and Control System

EXECUTIVE SUMMARY

Over the past few years, shrinking defense budgets and the fall of the Soviet Union have lead to significant reductions of the United States Armed Forces. These force reductions have caused military leaders to seek new ways to maximize the use and capabilities offered by joint military forces. History has shown that joint interoperability among the services' C4I systems affects the success of joint military operations. Consequently, this has developed a need for all military services to formally educate some of their officers in joint Command, Control, Communications, and Intelligence (C4I). Military officers may receive this formal education by participating in programs like the Joint C4I Systems curriculum offered at the Naval Postgraduate School. The key objective of this education is to provide the officers with the knowledge they need to anticipate and support their commander's C4I joint interoperability requirements.

Military officers attending the Joint C4I Systems curriculum at the Naval Postgraduate School complete a seven quarter education program where they receive courses in a wide range of technical areas that focus on Command and Control (C2), Command, Control, and Communications (C3), and C4I related subjects. The curriculum is designed to continually build on the knowledge acquired from previous courses.

A Joint C4I Systems class typically contains students from all four services. Since they arrive with diverse background experiences, they begin their education by taking an introductory level course in C3. The goal of this course is to provide first quarter C4I Systems students a basic foundation for use in other courses in the course matrix will be taught or later addressed. The introductory C3 course is a survey course that includes a wide variety of C3 related topics and issues. Due to the large number of C3 topics presented, most are only briefly discussed.

Additional reading assignments or courses taken later in the curriculum will provide additional depth in many of these areas. However, many topics are not covered with the focus or level of detail desired.

This thesis serves a dual purpose. The first is to provide students with a course primer that captures and emphasizes key concepts or main ideas presented by both the course instructors and from required readings. It serves as a single source document that minimizes confusion by avoiding unnecessary and extraneous detail. By integrating this primer into the course, it will provide both the students and the instructors a common reference plan that clearly maps the direction for the introductory courses. This thesis will, by no means, totally eliminate outside reading assignments, but it will allow them to become more focused.

The second purpose of the thesis is to supplement course reference material by providing in depth discussions for topics that will not be addressed by other courses in the course matrix. These topics are fundamental to understanding potential application of ideas, concepts, and theories presented later in the curriculum. This thesis will also build a basic knowledge for understanding C3 related subjects presented by visiting guest lectures and routine video teleconferencing presentations. To accomplish this task, this thesis covers many broad areas in C3 to include: C2 related definitions; the military services's roles, C2 organizations, and warfighting philosophies, and the military services' C4I systems and communications support systems.

Chapter I defines and discusses the meaning of the basic C2 terminology including command, control, C2, C3, and C4I. Also presented is a description of the Lawson decision making model and its importance to C2.

Chapter II provides an executive overview of Department of Defense's organization, purpose, primary C4I system, and communication support systems.

This chapter provides an educational framework for understanding how the services contribute to the DoD's overall objectives.

Chapters III to VI describe the roles and missions, current C2 organizations, capabilities, limitations, and warfighting philosophies for each of the four military services. These chapters present how each service operates, deploys, and contributes to tactical, theater, and joint operations. The overall goal is to introduce students to the operational considerations required for employing C4I systems that will support the C2 needs of theater and tactical commanders.

Chapters VII to X identify basic C2 functions shared by all of the services and present the current C4I systems used to support them. Although strategic and national C4I systems are frequently referenced, the thesis focuses on theater and tactical level C4I systems. Even though advancing technology may soon lead to the replacement of the C4I systems presented in this thesis, having a basic knowledge of their current application, will continue to serve as a reference point for evaluating future replacement systems.

Chapter XI discusses ongoing C4I modernization initiatives. It presents an overview of the C4IFTW concept and the evolution of Global Command and Control System (GCCS).

Chapter XII concludes the thesis with recommendations for further research in areas that exceed its scope. Some of these areas include: C2 processes for organizational and operational decision making; special operation forces' organization; and joint level planning, organization, and deployment. Further research in these areas would further contribute to the introductory course objectives and better prepare students for follow-on courses in the Joint C4I Systems curriculum.

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I. INTRODUCTION

A. BACKGROUND

Today's military force has become much smaller over the past few years, due to the ending of the cold war and dwindling defense budgets. This has encouraged our military leaders to turn their attention toward the potential capabilities achievable through the effective application of joint military forces. History has often revealed that the success of joint operations depends heavily on the interoperability of among the military service's C4I communication systems. As a result, all of the services have now identified a need to formally educate their officers in joint command, control, and communications (C3).

Education programs such as the Joint Command, Control, Communications, and Intelligence (Joint C4I) curriculum taught at the Naval Postgraduate School, provides a means to satisfy this requirement. Each of the services are now sending selected officers to Naval Postgraduate School to receive this education. Officers participating in the Joint C4I curriculum are expected to eventually return to their organizations with the knowledge necessary to satisfy their commanders Command and Control (C2) needs in a joint environment.

Since these officers typically arrive to the Joint C4I curriculum having diverse backgrounds and experiences, they are required to take an introductory course in Command, Control, and Communications (C3) during their first quarter. This course introduces a wide range of C3 related topics from which other courses in the curriculum will be based. Since the introductory C3 is taught in only one quarter, class time is a major constraint that prevents the course instructors from presenting any one topic in-depth. To over come this constraint, students are assigned numerous external reading assignments to develop a deeper

understanding of C3 related topics and issues. Since these assignments are taken from a number of different references, they often overwhelm students with extraneous detail leading to possible confusion or distract their attention from the true learning objectives of the course. Improved correlation between the outside reading assignments and classroom presentations, calls for a course primer that clearly establishes a harmonic relation between them.

B. PURPOSE

The overall goal of this thesis is to improve the quality of education in the introductory C3 course by serving two purposes. The first purpose is to capture key points and ideas from external reading assignments and inclass instruction, by providing students with a course primer. The primer will serve as a single source document that emphasizes the course's main topics by avoiding extraneous detail in the external readings, as well as, provide course instructors and students a clear map for the course's direction. The second purpose of this thesis is to supplement the course reference material. It will provide students with more in-depth discussions on other important C3 related topics, not covered by existing reference materials or addressed in follow-on courses. These topics include: C2 related definitions; the military services's roles, C2 organizations, and warfighting philosophies; and the military services' C4I systems and communications support systems. By providing detailed discussions on these topics, students can develop the basic knowledge necessary for understanding C3 related subjects presented by visiting guest lectures and routine video teleconferencing presentations.

C. SCOPE

The scope of this thesis is oriented toward each of the military services' roles, organizations, warfighting philosophies, C4I systems, and communication

support systems used at operational and tactical levels. The scope of this thesis is driven primarily by the notion that a majority of officers attending the Joint C4I Curriculum at the Naval Postgraduate School are normally mid-grade officers, who typically return to organizations at operational and tactical levels. This thesis focuses on regional CINCs roles, organization, and C4I systems vice those of the functional CINCs. Although an overview of DoD's functions and organization are briefly discussed in Chapter II, more detailed presentations at this level fall beyond the scope of this thesis. Other important areas that support national, strategic, and joint decision making that exceed the scope of this thesis include:

- Strategic nuclear C2, organizations, and C4I systems (NORAD)
- Joint Operations Planning System (JOPS)
- Joint Deployment System (JDS)
- Unique joint contingency C4I and communication support systems
- Administrative requirements, organizations, and functions at the national and operational levels
- Defense level planning systems (JOPES, JSPS, PPBS, ACQ)
- Functional CINCs' roles, organizations, and C4I systems
- Special Operations Forces missions, organizations, C4I systems and communications support systems.
- National and strategic level sensors and intelligence processing

D. THESIS ORGANIZATION

The remaining part of this chapter defines and discusses the meaning of the basic C2 terminology including command, control, C2, C3, and C4I. Also

presented is a description of the Lawson decision making model and its importance to C2.

Chapter II provides an executive overview of Department of Defense's organization, purpose, primary C4I system, and communication support systems. This chapter provides an educational framework for understanding how the services contribute to the DoD's overall objectives.

Chapters III to VI describe the roles and missions, current C2 organizations, capabilities, limitations, and warfighting philosophies for each of the four military services. These chapters present how each service operates, deploys, and contributes to tactical, theater, and joint operations. The overall goal is to introduce students to the operational considerations required for employing C4I systems that will support the C2 needs of theater and tactical commanders.

Chapters VII to X identify basic C2 functions shared by all of the services and present the current C4I systems used to support them. Although strategic and national C4I systems are frequently referenced, the thesis focuses on theater and tactical level C4I systems. Even though advancing technology may soon lead to the replacement of the C4I systems presented in this thesis, having a basic knowledge of their current application, will continue to serve as a reference point for evaluating future replacement systems.

Chapter XI concludes the thesis with a discussion of ongoing C4I modernization initiatives. It presents an overview of the C4IFTW concept and the evolution of Global Command and Control System (GCCS).

Chapter XII concludes the thesis with recommendations for further research in areas that exceed its scope. Some of these areas include: C2 processes for organizational and operational decision making; special operation forces' organization; and joint level planning, organization, and deployment. Further research in these areas would further contribute to the teaching objectives in the

introductory course and better prepare students for follow-on courses in the Joint C4I Systems curriculum.

E. C2" DEFINED

The terms *command, control, command and control* (C2), and *command, control, and communications* (C3) have become a common part of today's military vocabulary. Although initially their definitions may seem apparent, these terms actually possess a variety of meanings depending on the user's interest in command and control. For example, engineers might view these definitions in terms of the communications facilities, power requirements, network configurations, and bandwidth availability. To military personnel managers, they may interpret the meanings of command and control terms as it pertains to the human aspect of the C2 process. Still others, who plan military operations, may interpret the definitions in terms of their contributions to operational goals. Ultimately, the different meanings are associated with one's specific interest in the area of C2. A common awareness of the dichotomies that exist in C2 related terminology is useful for productive and cohesive military planning of tomorrow's armed forces. [Ref. 1: pp. 5-12]

The main point of this chapter is to present how commonly used C2 terms defined by the Joint Pub 1-02 (DoD Dictionary of Military and Associated Terms) are interpreted by two prominent figures in the study of C2; Frank Snyder and Thomas Coakley. Familiarization with their interpretation of C2 helps understanding of complex issues associated with using C2 systems to support modern warfare.

1. Command

To form the basis for comparison, Joint Pub 1-02 provides a standard definition for *command* as follows:

> The authority vested in an individual of the armed forces for the direction, coordination, and control of military forces. [Ref. 2: p. 77].

This definition implies that command is a designated authority granted to commanders, so that they can lawfully direct and manage their resources to accomplish the orders assigned by higher echelons. This authority includes the responsibility for the success or failure of their organizations. Although the authority can be delegated down to the lowest practical level, the responsibility is nontransferable and resides with the original appointee.

In his book "Command and Control: the Literature and Commentaries," Frank Snyder adopts the first sentence of C2, defined in the Joint Pub 1-02, as his definition for command. He defines command as:

> The exercise of authority and direction by a properly designated commander over his assigned forces in the accomplishment of the mission. [Ref. 2: p. 77]

Snyder emphasizes that command is a function to be performed through some form of human activity, rather than just an authority as defined in Joint Pub 1-02. This human activity, which integrates the human dimension into the C2 process, is based on an individual's attributes such as leadership, courage, judgement, and foresight. Commanders must effectively apply these attributes to successfully motivate subordinates to carry out their orders. [Ref. 3: pp. 11-14]

Thomas Coakley views the definition of command as a synonym for the phrase *command and control*. By using historic examples in his book, "Command

and Control for War and Peace," Coakley illustrates the phrase *command and control* originated from the single term command. In the early days when the force structure was simple, Alexandria the Great performed the functions of command by directing and leading his forces by himself. By relying on his own abilities, Alexandria assessed the enemy situation, developed a battle plan, and observed the results of his decisions. Coakley postulates that the phrase *command and control* replaced the term command following World War II. During this period, the force structure evolved into a complex organization. As a result, commanders could no longer rely solely on their own abilities, but instead required staff assistance to command their forces. Coakley suggests that command functions have evolved from a tactical to a strategic orientation, concerned with associating only the "big picture" of the battle with command. [Ref. 1: pp. 34-36]

2. Control

Department of Defense (DoD) and Snyder both agree that *control* is defined as:

> The authority which may be less than full command exercised by a commander over part of the activities of subordinate or other organizations. [Ref. 2: p. 88]

This definition describes situations where commanders only have temporary authority over assigned forces to perform specific command functions such as administrative, operational, or tactical control. For example, an army aviation support company maybe operationally attached to an infantry brigade to provide lift support for a specific mission. In this case, the brigade commander would have temporary control over the aviation assets only for the duration of the mission. Upon completion of the mission, the control of the aviation support company would return to its parent unit.

Coakley views the meaning of control as having tactical or operational connotations concerned with the immediate management of forces. He further presents the ideas that the word control has different meanings depending on the users' point of view. For example, an army commander of force A may view control from an organizational perspective as it relates to managing the operational and administrative activities of another force B. From an air force commander's perspective he or she might view control in terms of specific systems or aircraft such as directing an aircraft to attack a designated target. The Navy, on the other hand, may view the term control as a means of constraint, such as restricting or limiting a specific ship from attacking an enemy vessel. Coakley also presents the push-pull dichotomy that exists between meaning of terms command and control. He defines command as pushing forces into combat and control as holding the forces back. Although Coakley shares the common idea with DoD and Snyder that control relates to tactical or operational control, he differs by defining control as leash that commanders use to limit or constrain activities of their force. In contrast, DoD and Snyder imply that constraint is only part of control. They view control in a broader sense by suggesting that someone other than the commander may exercise control over deployed forces or assets. Take for instance, an air traffic controller may direct pilots to fly specific directions, even though they are not the commander. DoD and Snyder further suggest that control is a subset of command, meaning that if a commander has command, he will also have control. Conversely, control can occur independently, without the presence of command. [Ref. 1: pp. 37-38]

3. Command and Control

DoD defines the phrase *command and control* as follows:

> The exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of the mission.

> Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission. [Ref. 2: p. 77]

This definition implies that command and control is a process by which the commander plans, directs, coordinates, and controls his assigned resources to achieve some common objective or goal.

Similarly, Snyder adopts the following subset of DoD's definition to define command and control as a process:

> Procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission. [Ref. 2: p. 77]

Snyder expounds on this definition, by explaining that the C2 process is initiated when a commander receives information about the situation. The commander then decides the best possible course of action, before directing his subordinates to execute his decision. The process concludes when the commander receives feedback on the effectiveness of his decision and further directs adjustments, as needed, to satisfy mission requirements. [Ref. 3: p. 11-12]

a. Types of Decisions

Commanders generally make three types of decisions: organizational, informational, and operational decisions. Organizational decisions are decisions usually made before the start of the mission. They establish the structure of the chain of command, dictate levels of authority, and provide a path for reporting information within the organization. Informational decisions are the decisions that commanders make to identify the type of information, format, and

frequency they need to accurately access the situation and make operational decisions. Operational decisions are the decisions that tell subordinate activities what course of actions to execute to accomplish their assigned mission. [Ref. 3: p. 13]

Coakley, like DoD and Snyder, also defines C2 as a process:

> C2 is everything an executive uses in making decisions and seeing they're carried out; it includes the authority accruing from his or her appointment to a position and involves people, information, procedures, equipment, and the executive's own mind. A C2 process is a series of functions which include gathering information, making decisions, and monitoring results. [Ref. 1: p. 53]

Coakley's definition differs from DoD's and Snyder's definitions because Coakley uses more general terminology that applies beyond a military context. In his definition, Coakley uses the term executive instead of commander to identify those individuals assigned to leadership positions. These positions inherit a certain amount of authority to direct others to perform some action. The degree of authority depends primarily on the level of that position within an organizational hierarchy. Coakley defines the C2 process, similar to DoD and Snyder, as a relation between executives (commanders) and their responsibility of managing their assigned resources to achieve a particular objective. The second part of Coakley's definition for C2 focuses on the input, processing, and output of information by the decision maker.

b. C2 Analogy

To illustrate the C2 process, Coakley uses the analogy of a head coach of a football team and compares it to that of a commander. The head coach, similar to the commander, is the primary decision maker for the organization. Before an important game, the head coach must obtain information about the

opposing team that includes their capabilities, strengths, and weaknesses. Prior to a mission, a commander must perform a similar function of obtaining information about the enemy. Both the coach and the commander must rely on scouts and subordinates to provide this information in a useful format, so they can make future decisions. Once the coach receives this information, he, like the commander, must rely on his own experience to formulate and choose a strategy that offers his organization the best advantage. After the game or mission begins, the coach (commander) must receive feedback, so they can constantly evaluate their progress and direct adjustments, as necessary to achieve their final goal. This analogy provides a useful tool for understanding the basic concept of any C2 process. [Ref. 1: pp. 18-23]

c. Lawson Model

The success or failure of military forces in combat often depends greatly on the speed and efficiency of their C2 process. Commanders must acquire real-time information, make tactical decisions, and distribute information to subordinates faster than the enemy, in order to, maximize their chances for victory. Joel S. Lawson developed an excellent model, commonly called the "Lawson Model," that replicates the C2 process [Ref. 1: p. 32]. Figure 1 shows the five functions that compose of the Lawson model are sense, process, compare, decide and act functions.

The *sense* function is the collection of data and information about the situation or environment, such as the positions of friendly and enemy forces, terrain, obstacles, and types of weapons. Once information is collected from both internal and external sources, a commander and staff must perform the *process*

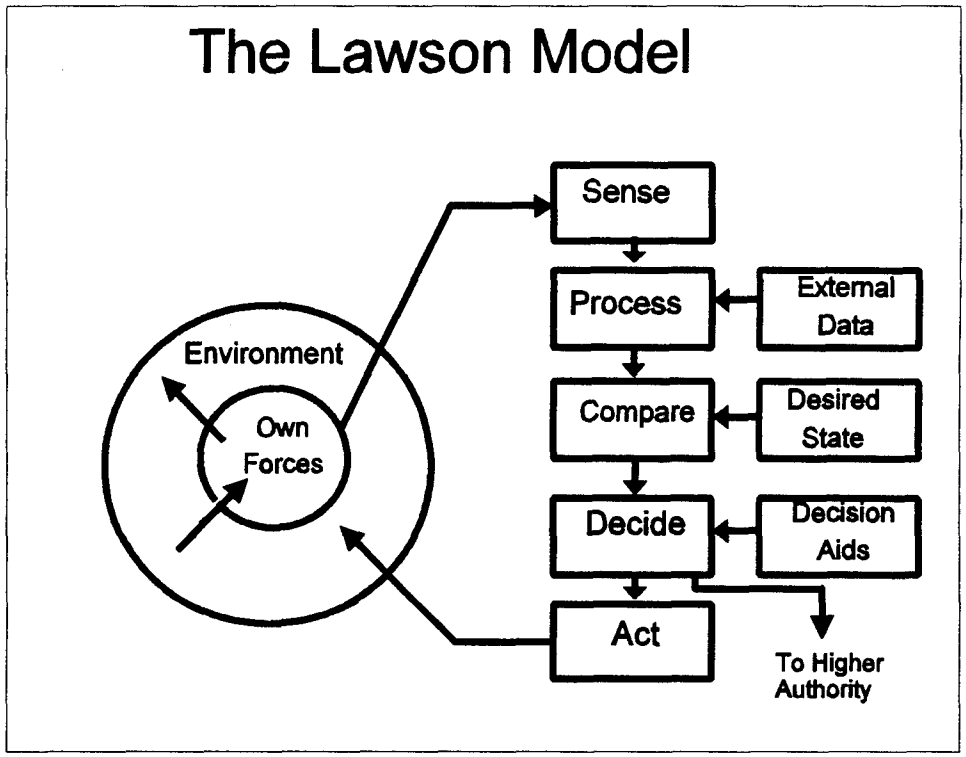

Figure 1. The Lawson Model. [After Ref. 1: p. 32]

function. The *process* function is the correlation of collected information to develop possible courses of actions. These courses of action are analyzed and compared to one another to determine the tradeoffs and benefits relative to the desired goal or state. This is called the *compare* function. The commander must then perform the *decide* function by using available decision aids and input from higher authority to decide which coarse of action will best satisfy the mission. Upon making this decision, the commander directs his forces to execute his orders, called the *act* function. The result of this act may cause commanders to issue new orders to his forces. As these forces interact with the enemy, they perturb the environment. The C2 model senses these perturbations causing it to start another

C2 cycle. The Lawson model represents a methodical decision making loop that has often modeled how commanders made decisions in the past. Commanders, who access the situation, make decisions, and provide direction to their forces at a faster rate than that of their adversaries, are more likely to lead their forces to decisive victories. This is commonly termed "Getting inside of the enemy's C2 cycle". [Ref. 1: pp. 32-33]

4. Command and Control Systems

Systems that support the C2 process may be called *command and control* (C2) *systems*, *command, control, and communications* (C3) *systems* and *command, control, communications, computers* (C4) *systems* and so forth. DOD defines command and control system as:

> The facilities, equipment, communications, procedures, and personnel essential to a commander for planning, directing, and controlling operations of assigned forces pursuant to the mission assigned. [Ref. 2: p. 77]

This definition encompasses all of the different variations of a C2 system by implying that it is a composite of all resources and tools a commander needs to manage his force and achieve his objectives.

Snyder favors the phrase C4 systems and defines it using the middle part of DOD's definition:

> An arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander. [Ref. 3: p. 11]

This definition may seem straight forward, however, the types of components that make up C2 systems have occasionally been a source of debate among politicians and military leaders. For example, some believe that C2 systems should include intelligence (C3I), since commanders require it for making decisions. Others

believe that computers should be added to the list of C2 systems and intelligence should be kept separate. These differences in interpretation of DoD's definition for C2 systems have increased the difficulty for military leaders in the planning of future C2 systems. [Ref. 1: pp. 9-10]

Snyder, like Coakley, supports the same general idea that the function of any C2 system is to support the C2 process. Snyder further points out that regardless of different phrases one chooses to refer to C2 systems, all are acceptable, as long as they refer to system(s) that support the C2 process. [Ref. 3: p. 12]

F. SUMMARY

This chapter introduced several different interpretations of the terms command, control, command and control, and command and control systems. Command is defined as some level of authority and responsibility given to commanders to perform a mission. Control is less than full command in which commanders have limited and temporary authority over assigned forces to conduct some specific function of control. Command and control is described as a process that produces one of the three types of decisions; organizational, informational, and operational. The Lawson model illustrates the five functions associated with the C2 process that includes sense, process, compare, decide, and act. Although many variations of the term C2 systems exist, all share a common purpose of supporting the C2 process. In addition, the components of C2 systems may simultaneously support one or multiple C2 processes, at different levels of command.

The next four chapters will describe the roles and missions, current C2 organizations, capabilities, limitations, and warfighting philosophies for each of the military services. These chapters will also present how each service operates, deploys, and contributes their capabilities to tactical, theater, and joint operations.

This information will develop an appreciation and understanding for the operational considerations to employ C4I systems that support theater and tactical commanders.

II. DEPARTMENT OF DEFENSE OVERVIEW

In the previous chapter the basic C2 related definitions were defined to facilitate a better understanding of the scope, ideas, and concepts presented throughout this thesis. Before presenting each of the roles, missions, and warfighting philosophies for each of the military services, the reader should become familiar with the Department of Defense's (DoD) organization and purpose. To achieve this goal, this chapter briefly describes the DoD's organizational structure, primary functions, C4I systems, and key communication support systems. This will build an educational framework necessary for understanding information discussed in subsequent chapters.

A. DEPARTMENT OF DEFENSE

The DoD was originally created as the National Military Establishment (NME) by the National Security Act of 1947. It was renamed two years later as the Department of Defense (DoD) by the National Security Act of 1949. Today's DoD receives its direction, control, and authority from the National Command Authority (NCA) that is comprised of the President and the Secretary of Defense. They are granted by law the full or limited authority to direct the Armed Forces of the United States into military action as they deem necessary to enforce national and foreign policy, protect our national interests, and promote global stability. The NCA decisions are normally based on advice from the National Security Council (NSC). The NSC is composed of the President, Vice President, Secretary of State, and Secretary of Defense. The Chairman for Joint Chiefs of Staff and the Director of Central Intelligence Agency serve as advisors to the NSC. [Ref. 4: pp. 2-2 to 2-7]

The Secretary of Defense (SECDEF), under the authority of the President (Commander in Chief), provides direction and control over the DoD and its component agencies. He also advises the President on all matters relating to DoD activities. The Joint Chiefs of Staff (JCS), under the authority of the Chairman of the JCS, represent their respective military departments in advising the President, the SECDEF, and the NSC on service related issues. In a similar fashion, the Chairman himself serves as the principle military advisor to the NCA and NSC. Each of the Service Departments have their own Service Secretary who receives guidance, direction, and specific military objectives from the SECDEF. [Ref. 4: p. 2-4]

1. DoD Organization

There are a number of components that make up the DoD organization. These components include Secretary of Defense, Chairman of JCS, JCS, DoD staff, military departments, DoD agencies, Combatant Commands, and DoD field activities, as shown in Figure 2. [Ref. 4: p. 2-4]

2. DoD Functions and Responsibilities

The above components collectively contribute to the DoD's overall objectives that as prescribed by the National Security act of 1947. These objectives are: [Ref. 4: p. 2-5]

- Support and defend the Constitution of the United States against all enemies, foreign and domestic
- Ensure, by timely and effective military action, the security of the United States, its possessions, and areas vital to its interest
- Uphold and advance the national policies and interests of the United States

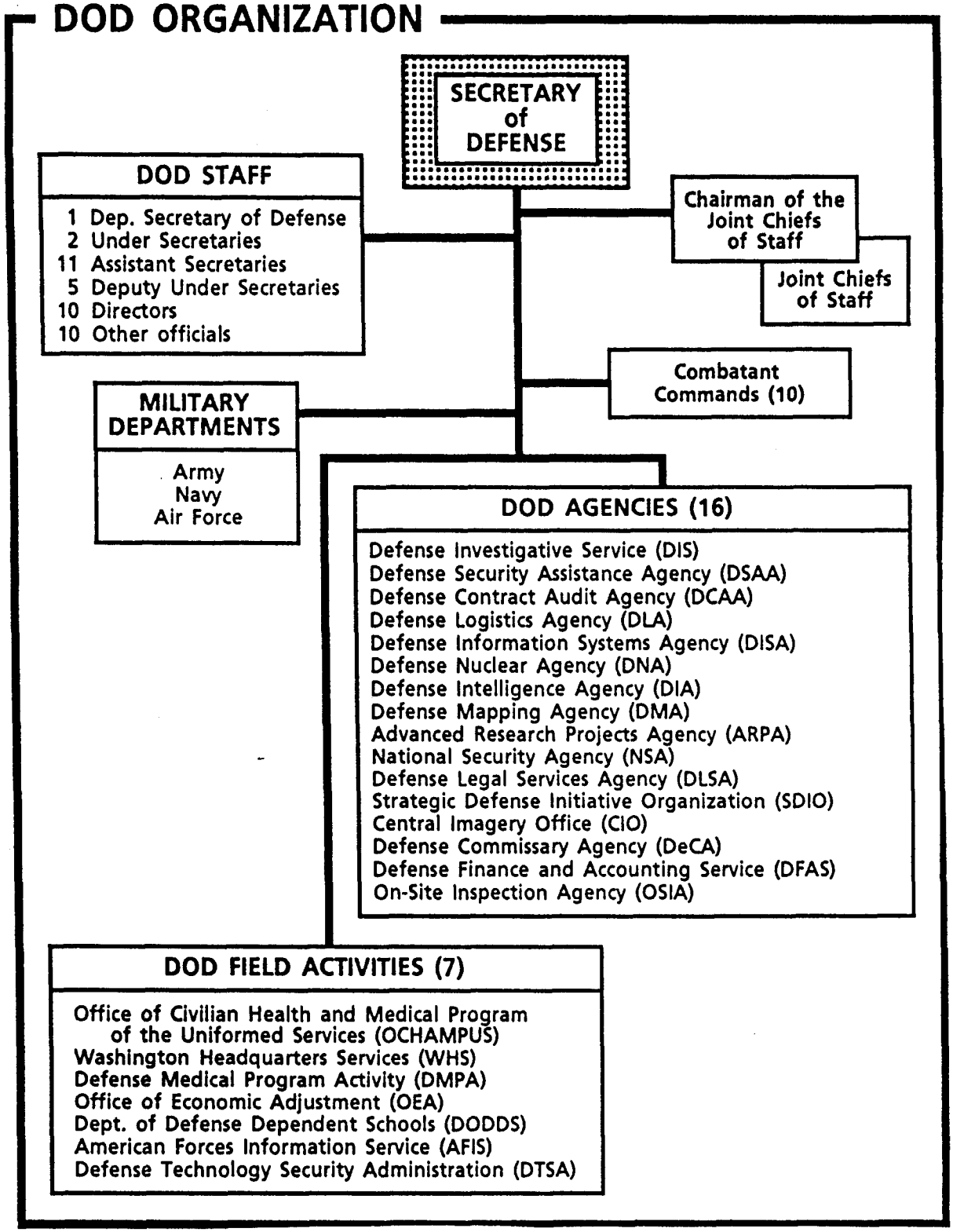

Figure 2. DoD Organization. [After Ref. 4]

The DoD Directive 5100.1 outlines specific support and operational responsibilities for DoD that are performed by the Administrative/support and operational chains of command respectively. The administrative/support chain of command exists and runs from the President to the SECDEF to the service secretaries of the military departments to service chiefs and then to the Component Commanders in Chiefs (CINCS) of military forces. Some examples of the responsibilities or functions of this chain of command include; recruiting, organizing, supplying, equipping, training, servicing, mobilizing, administering, and maintaining the military forces. The operational chain of command runs from the President to the SECDEF and then to the Unified Combatant Commanders (CINCS). It is important to note that the Chairman of the JCS plays a key role in operational chain of command by acting as the primary military advisor to the NCA and by facilitating communications between the NCA and the CINCS as they perform their assigned military missions. Some examples of operational responsibilities (functions) are military advice, strategic direction, operational planning, and C2 over Combatant Commands. Even though each of the military services perform both support and operational functions, this thesis focuses primarily on their operational responsibilities and their related C2 organizational structures. These will be addressed in Chapters III through VI. [Ref. 5: p. 2]

DoD's operational C2 functions differ from the basic C2 functions commonly performed at the theater and tactical levels. The five C2 functions common to the theater and tactical levels will be presented in Chapters VII through X. These C2 functions are common to each of the military services and include intelligence, air operations (or air defense), fire support, maneuver, and logistics. These C2 functions will serve as a baseline for presenting the contributing utilities and values of each of the services' C4I systems, as they support the operational chain of command.

The fundamental difference between Unified and a Specified Combatant Command (when activated) is that an Unified Combatant Command is composed of forces from two or more military departments, where as a Specified Combatant Command is composed of forces from only a single military department. The commanders for Unified and Specified Combatant Commands are called Commanders in Chief (CINCS). These organizations are generally assigned broad, continuing missions in their designated regions. [Ref. 4: p. 2-19]

B. DoD C4I SYSTEM (WWMCCS)

The DoD accomplishes the functions and responsibilites discussed in the previous section, by using their primary C4I system called the World-Wide Military Command and Control System (WWMCCS). This system supports DoD by extending C2 from the NCA to the component CINCS. WWMCCS automates the information exchange through a globally dispersed WWMCCS Intercomputer Network (WIN) that gives users the capability to review, update, and exchange information with computer databases at various locations. The system also is capable of interfacing with other C2 systems such as: [Ref. 4: pp. 2-25 to 2-28]

- Presidential Command and Control System
- Non-DoD Command and Control Systems (State Department, Central Intelligence Agency (CIA), United Nations (UN), Coast Guard)
- Tactical C4I Systems

WWMCCS is composed of five elements including: communications, warning, executive aids, command facilities, and data collection/processing. These elements are used on a daily basis by DoD and form the JCS to the Component Commanders to support their operational requirements and to keep

abreast of the readiness state of their forces. [Ref. 4: pp. 2-26 to 2-27]

A key subcomponent of WWMCCS is called the National Military Command System (NMCS). This component serves as the main C4I system that supports primary and alternate command posts such as the National Military Command Center (NMCC), NMCC Site R, the National Emergency Airborne Command Post (NEACP), and other command posts designated by the SECDEF. The NMCS allows the effective coordination of military plans and operations with other outside activities such as: [Ref. 4: pp. 2-29 to 2-30]

- White House Situation Room
- CIA Operations Center
- Department of State Operations Center
- National Coordination Center for Telecommunications
- United Nations Military Missions
- U.S. Coast Guard Operations Center
- Federal Aviation Administration Executive Communications Control Center

One of the principle features of WWMCCS is the automated support that it provides to the Joint Operational Planning and Execution System (JOPES). The JOPES is an integrated senior-level, decision-making system used by the NCA and throughout the Joint Planning and Execution Community (JPEC). It assists users in determining the best method of accomplishing assigned tasks and directs the necessary actions accordingly. It is composed of policies, procedures, personnel, and facilities that interface with automated data processing systems, such as those provided by WWMCCS, to support operational requirements during deliberate and

crises action planning. JOPES interfaces with a number of other planning and support systems used at the DoD level such as: [Ref. 4: pp. 2-30 to 2-31]

- Logistics Sustainment Analysis and Feasibility Estimator (LOGSAFE)
- Dynamic Analysis and Replanning Tool (DART)
- Joint Flow and Analysis System for Transportation (JFAST)
- Force Augmentation Planning and Execution System (FAPES)

Despite the many capabilities offered by WWMCCS, further improvements to this system were halted in October 1992. This was not caused by the lack of use, but rather by technical limitations imposed by the growing crisis planning needs of the JPEC. On December 15, 1995, WWMCCS will be replaced by a new, more capable, system called Global Command and Control System (GCCS). It will contribute to the approved C4I For The Warrior (C4IFTW) concept that will eventually create a seamless C4I architecture. Both GCCS and C4IFTW will be discussed later in Chapter XI. [Ref. 4: p. 2-39]

C. DOD COMMUNICATIONS SUPPORT SYSTEMS

The DoD key communications support system that provides connectivity for DoD's C4I and contingency planning systems is called the Defense Communications System (DCS). The DCS extends connectivity from the NCA to theater tactical networks (area common user systems). The primary purpose of the DCS is to provide users long-haul communications services and strategic access to a wide variety of defense communications networks or systems. These networks or systems include the Defense Data Network (DDN), the Defense Switched Network (DSN), and the Defense Message System (DMS). Long-haul

connectivity between theater DCS entry stations and defense networks is typically provided by Defense Satellite Communication Systems (DSCS), commercial satellites, leased satellites, or fiber-optic cable. The Defense Information System Agency is the lead agency responsible for managing and controlling the DCS assets to ensure users are provided continuous, reliable, and responsive communication services. [Ref. 6: pp. 7-14 to 7-36]

1. Defense Data Network (DDN)

The DDN is a common-user communications network that provides the global transfer or exchange of information among diverse types of computers, terminals, and workstations. The network is composed of more than 350 Packet Switched Nodes (PSN), 650 trunks, 250 Terminal Access Controllers, 1900 hosts, and 4800 terminals. There are four types of DDNs used to pass unclassified and classified data. These types include; the Military Net (MILNET) for passing unclassified data, the Defense Secure Net 1 (DSNET 1) for passing Secret level data, the Defense Secure Net 2 (DSNET 2) for passing Top Secret data, and the Defense Secure Net 3 (DSNET 3) for passing SCI compartmental information. The DDN is currently transitioning to the Defense Information System Network (DISN). The DISN is a composite of Joint Worldwide Intelligence Communications System (JWICS), Nonsecure Internet Protocal Router Network (NIPRNET), and Secure Internet Protocal Router Network (SIPRNET). [Ref. 6: p. 7-22]

2. Defense Switched Network (DSN)

The DSN serves both common users and dedicated subscribers with a general purpose voice network. It provide its users with secure or nonsecure voice and teleconferencing long distance services. This switched network interfaces

with the services' AN/TTC-39 Tactical Circuit Switches and the Defense Commercial Telecommunications Network (DCTN). [Ref. 6: p. 7-32]

3. Defense Message System (DMS)

The DMS is a global message communications network that processes record traffic between strategically positioned DCS message centers (referred to in the past as AUTODIN Switching Centers). It is designed to support both general users and the intelligence community (at all security levels). The DMS will interface with the services, AN/TYC-39 Tactical Message Switches by using message store and forward techniques. [Ref. 6: p. 7-14]

4. Satellite Communications

There are a number of different types of satellites used by the services and DoD to provide long-haul connectivity for the DCS. Some of these satellites include DSCS satellites, Military Satellite Relay System (MILSTAR) satellites, Fleet Satellites (FLTSAT), and Leased Satellites (LEASAT). Since the Navy is the primary users for the FLTSAT and LEASAT, they will be discussed later in Chapter VII, under the Navy's communication support systems.

a. Defense Satellite Communication System (DSCS) Satellites

The DSCS are government owned multichannel Super High Frequency (SHF) satellites positioned in geosynchronous orbit. These satellites provide earth, narrow, and area coverage from 75^0 North latitude to 75^0 South latitude to give users long-range connectivity into DCS networks. They are part of a Joint program to support long distance services necessary to pass intelligence data, emergency action messages, and critical C2 information. Currently, there are

two versions of the DSCS satellites in operation: DSCS II and DSCS III. [Ref. 6: p. 7-28]

b. Military Satellite System (MILSTAR)

The MILSTAR is a new military satellite communications system currently being installed. This satellite system will support multi-service tactical mobile forces with real-time battle management functions such as air tasking orders and imagery dissemination. Since MILSTAR satellites will be Extremely High Frequency (EHF) systems, they will offer a large operating bandwidth that is capable of supporting very high data rates (T-1/1.544 Mbps). To increase the system survivability and reliability, MILSTAR will be able to operate in adverse electronic warfare environments, due to its anti-attack, anti-jam characteristics. After their installation, MILSTAR satellites will also be fully compatible with the Navy's new EHF fleet satellites which it plans to install on selected ships, submarines, shore facilities, and aircraft. [Ref. 7: p. 29]

Presented above are strategic level communications support systems that support DoD's C4I and contingency planning systems. As stated earlier, these communications support systems provide connectivity from DoD to the theaters. Later in Chapters VII through X, discussions on each service's communications support systems will be oriented toward those used at the theater and tactical levels. In these discussions the services' communications support systems will be categorized as either a theater or a tactical systems. This approach allows a standard treatment and presentation for the various types of communications used across each of the military services. The determination for which category the systems are placed will be based on some or all of the following criterion:

- Span of C2 supported by the system (local or theater level)
- Degree of interface with the strategic network (direct or indirect)
- Location of the system (communication zone or combat zone)
- Level of the subscriber (theater or unit level)

The systems are categorized subjectively. This does not imply the categories have discrete boundaries. In fact, as communication support systems in all the services continue to evolve with advancing technology and a joint orientation, the boundaries between theater and tactical communications will become even less defined.

D. SUMMARY

This chapter provided an executive overview of the DoD's organization, purpose, primary C4I systems, and communications support systems. It began by explaining the composition and role of the NCA, NSC, and the statutory advisers. This was followed by a list of the major elements that compose the DoD and a brief look at DoD's primary objectives. This chapter also addressed the adminstrative/support and operational chain of command that exist within the DoD. Their specific C2 functions (responsibilities) were outlined in DoD Directive 5100.1. The WWMCCS C4I system was briefly described as DoD's primary C4I system used to perform these functions and coordinate required military actions among all of the DoD's agencies, activities, military departments, and CINCs. Long-haul communications that support WWMCCS and extend C2 from the NCA to the theater level was provided by various DCS communications networks. The next four chapters will describe the roles, organization, and warfighting philosophies of each of the military services as they contribute to the achievement of the DoD's overall objectives.

III. U.S. NAVY MISSION, ORGANIZATION, AND PHILOSOPHY

The key to comprehending how the Navy exercises their command and control process requires some familiarization with its primary missions, organization, and warfighting philosophy. This chapter provides an overview of each of these areas. A basic knowledge of the Navy's operational requirements will facilitate a better understanding of their C2 requirements and the types of communications systems they use. These systems will be described later in Chapter VII.

A. FUNCTIONAL ROLES OF THE NAVY

The U.S. Navy has three primary functions. These functions are sea control, power projection, and sealift operations.

1. Sea Control

Total control of the seas gives the National Command Authority (NCA) the capability to project global military power in response to international crises. To sustain or reinforce the forward presence of military forces, the Navy must preserve its unencumbered access to Sea Lines of Communications (SLOC,) suitable for sealifting other military forces and hardware. The projection of this military presence is essential to the nation's ability to enforce United Nations (UN) sanctions, international law, and national foreign policy. [Ref. 8: p. I-1-10]

The U.S. has always relied heavily on the free access to the sea to import and export items such as technology, agriculture, raw materials, and finished products. This is essential to the country's economic stability and growth which ultimately has a profound impact on the size and capabilities of our military forces. The U.S. has other interests in the seas, such as the protection of our daily

transoceanic air flights, critical lines of communications, and coastal defense. Throughout U.S. history, the nation has been reminded of the strategic importance of being a "maritime" nation. These reminders range from the need to protect American merchant ships in the Mediterranean from barbaric pirates in the late 1700's to providing multidimensional avenues of attack against Iraq during Desert Storm. Control of the seas provides the U.S. a strategic media, by which it uses as a natural barrier, to protect itself from hostile nations, or as an avenue to sealift heavy armed forces worldwide in response to international crises. [Ref. 9: pp. 3-6]

The Navy is responsible for maintaining sea control that involves protecting sea lines of communications, securing operational areas, and safeguarding its deployed forces. Sea control is a pro-active and offensive strategy that allows the Navy to quickly acquire sea superiority when changing to wartime scenarios. This type of strategy immediately pushes the enemy into a defensive posture, causing him to react to the Navy's military actions. Furthermore, this offensive strategy denies the enemy use of the sea (battlespace maneuver area) while allowing the Navy to seize and retain the offensive initiative. [Ref. 4: p. I-1-10]

There are two types of missions associated with sea control: strategic and tactical. Strategic missions involve the Navy's role in neutralizing the enemy's efforts to deny friendly use of the sea, by employing stand-off style tactics. Examples of these tactics may include performing naval blockades and barriers, long-range naval gunfire against land targets, or conducting offensive mining operations. Tactical missions are associated with safeguarding naval forces or supporting other units participating in operations nearby. Examples of these are the removal of enemy barriers and obstacles at sea, providing naval gunfire support for local amphibious forces, and performing countermine operations. [Ref. 8: p. I-1-10]

Over the past few years, the Navy has increasingly become a key player in accomplishing missions called "other than war". To accomplish these missions, the Navy has relied on control of the sea lanes to transport humanitarian aid to third world countries, protect U.S. borders against uncontrolled immigration, perform active roles in drug intercept operations. Free access and unhindered use of the seas are paramount for the U.S. Navy to accomplish its assigned missions and to project U.S. military power to distant regions.

2. Power Projection

The U.S. Naval Forces enforce and execute the political, diplomatic, economic, and military objectives, outlined by the NCA, by projecting their military power to regional areas of interest. The forward presence of combat ready Naval Forces, capable carrying out a wide range of military operations, fosters regional stability and security. This Naval Force confirms the nation's commitment to preserving access to global resources, protecting our allied nations, and enforcing international laws and agreements. Additionally, forward positioning of combat ready and lethal naval forces serves as a deterrence to unruly and aggressive nations. These nations must consider the military consequences that could result from their use of weapons of mass destruction such as nuclear, chemical, and biological weapons. By projecting military forces into regions of interest, the Naval Forces possess the ability to quickly attack targets of opportunity in littoral areas with precise accuracy and substantial lethality. The prepositioning of port opening equipment and other military hardware provides the U.S. military additional resources to conduct more extensive operations ashore. Although the power projection of military forces is necessary to maintain regional stability, the NCA depends on the Navy to transport required military resources for the other services as discussed in the next section. [Ref. 8: p. I-1-10 and Ref. 9]

3. Sealift

The third major function of the Navy is to provide sealift capabilities to deploy military resources through SLOCs to specific regions of interest. Examples of these resources may include maintenance facilities, communications equipment, ammunition, and heavy weapons. They are critical to sustaining existing naval forces, or for supporting the other military service in follow-on military operations. Implied in the mission of transporting these resources to forward areas, is the Navy's responsibility of securing entry ports that facilitate the reinforcement of Marine and Army units, as they conduct combat land operations. [Ref. 8: p. I-1-10 and Ref. 9: p. 69]

To perform the three functions expected of today's Navy, it is equipped with highly trained sailors who operate some of the most advanced ships, submarines, and aircraft in the world. This provides the Navy with the mobility, flexibility, and firepower needed to safeguard the nation's interest at sea and around the globe.

B. NAVY ORGANIZATION AND STRUCTURE

The U.S. Navy's organization, like DoD, consists of two chain of commands to facilitate C2 from the NCA down to Naval operating forces. These are the administrative and the operational chain of commands, as shown in Figure 3. The NCA exercises leadership over the Navy by providing the Secretary of the Navy and the Commander in Chiefs (CINCs) of Combatant Commands (Unified) with a National Security Strategy necessary to achieve political and military objectives.

Although this thesis focuses on the operational chain of command, the Navy's administrative chain of command briefly discussed. This chain of command is unique to the Navy since it extends down to lower command levels

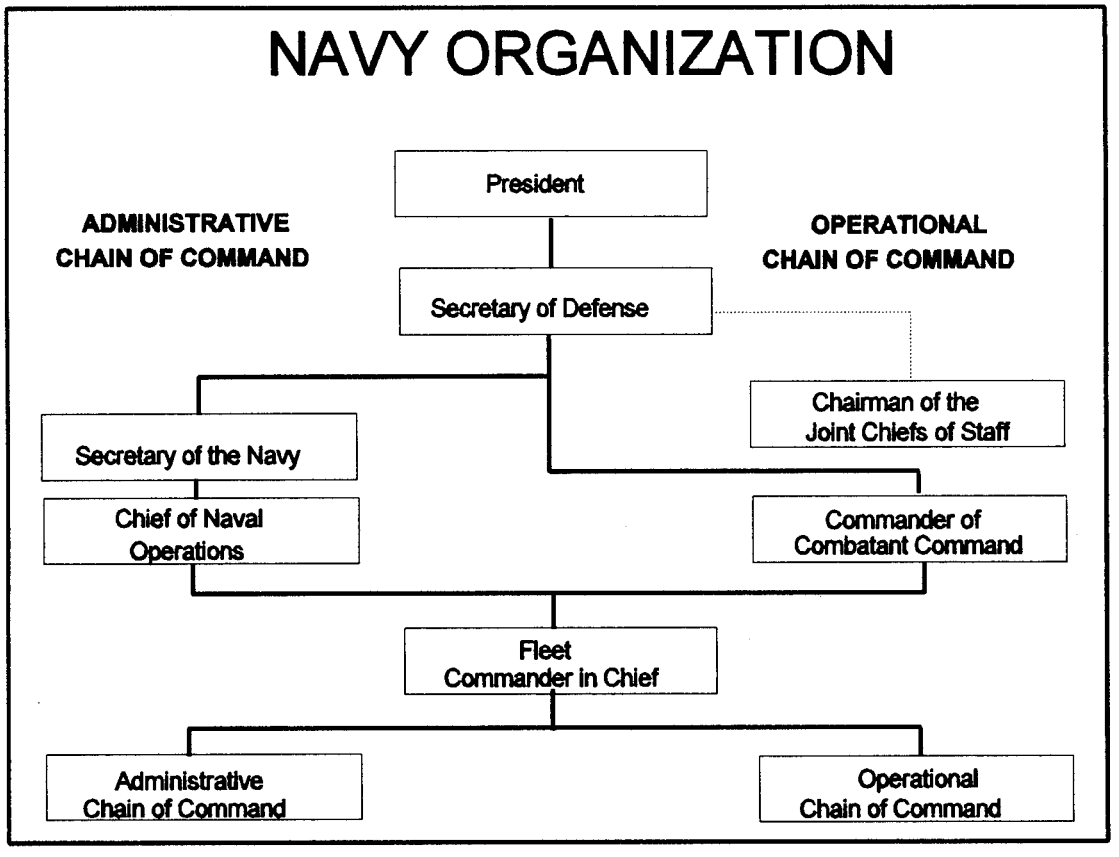

Figure 3. Navy Organization.

than compared to the other military services. The administrative chain of command, shown in Figure 4, is primarily concerned with the administrative and logistic activities that support Naval Forces. Some examples of this support include personnel, fuel, ammunition, maintenance, training, medical, legal services, as well as, support provided by shore based facilites. The Secretary of the Navy provides direction and control, and guidance to the Chief of Naval Operations (CNO) for managing shore based facilites and establishing adminstrative/support requirements. In turn, the CNO and the Fleet CINCs (four stars) are responsible for managing and controlling administrative activities of the

Administrative Chain of Command

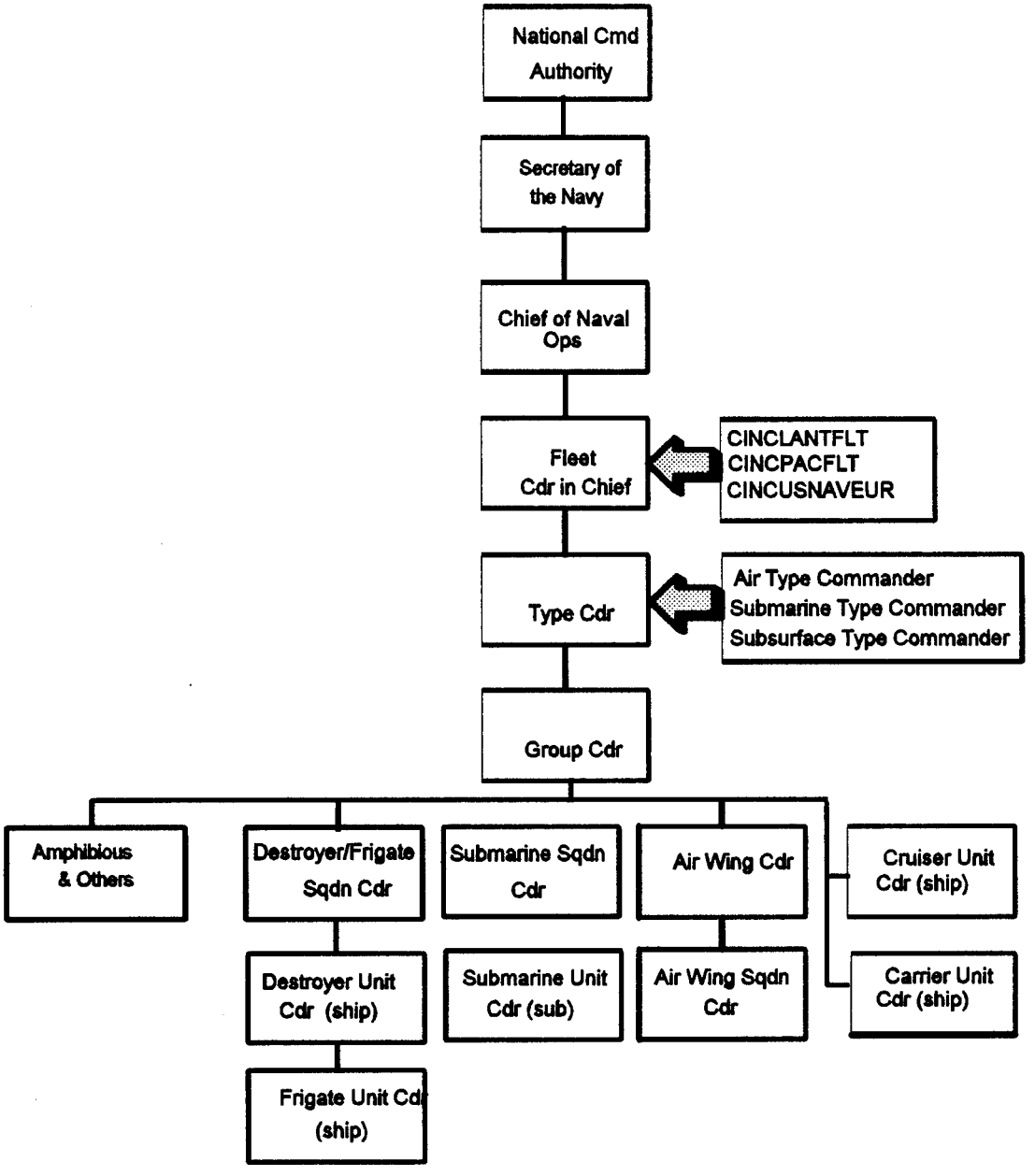

Figure 4. Administrative Chain of Command. [Ref. 10]

fleets assigned to their command. Type commanders (typically three stars), who are shore based, assist the Fleet CINCs by supervising all administrative and logistical support requirements of the operational forces within a particular fleet. There are usually three different Type commanders assigned to support each fleet's air (NAVAIR), surface (NAVSURF), and subsurface components (NAVSUB). For example, the three Type commanders for the Second Fleet units operating in the Atlantic Theater are the NAVAIRLANT, NAVSURFLANT, and NAVSUBLANT. Table 1 shows the assets each Type commander supports. Type commanders insure that Carrier Vessel Battle Groups (CVBGs) are fully mission capable when CVBGs deploy from their home ports. While at sea, the Type commanders continue to

TYPE COMMANDERS	PRINCIPLE EQUIPMENT
Air Type Commander	Air Wing Squadrons, Carriers
Surface Type Commander	Cruisers, Destroyers, Frigates, Oilers, Amphibious Ships, and other naval surface ships
Subsurface Type Commanders	Submarines

Table 1. Type Commanders Responsibilities. [After Ref. 10]

monitor the administrative needs of the CVBGs and provide support as required. The commanding officers of operating forces such as CVBG commanders, destroyer/frigate squadron commanders, and air wing commanders, are responsible for their units achieving a high level of combat readiness before deploying. Since cruisers and carriers do not have their own administrative squadrons, the CVBG commanders must share direct responsibility with the Type commanders in the readiness preparation of these vessels. [Ref. 8: pp. I-1-6 to I-1-7 and Ref. 10]

Figure 5 shows the operational chain of command that is used to manage the operational employment of naval units including force composition, location, movement, and deployment tasks. In addition, the operational chain of command

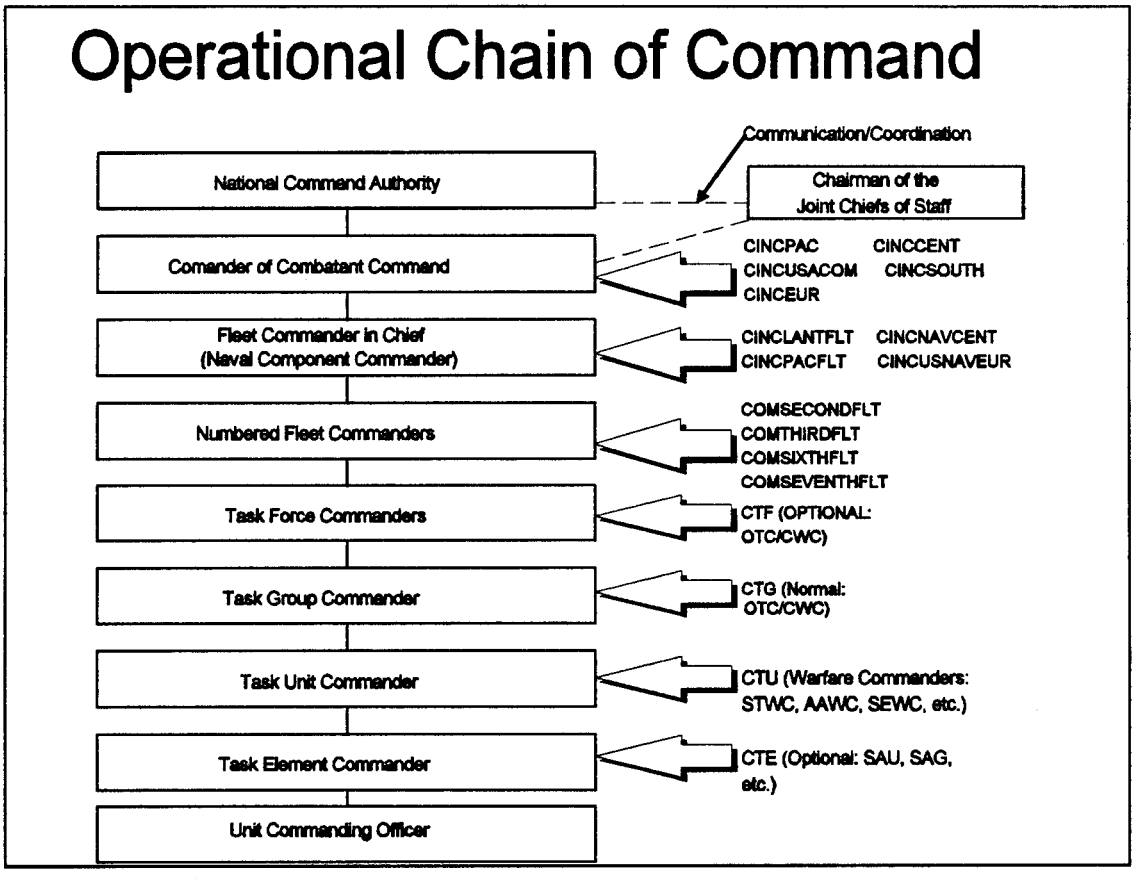

Figure 5. Operational Chain of Command. [After Ref. 4:p. I-1-1]

controls and manages the daily missions, training exercises, and transitions to wartime scenarios for all deployed naval forces. Numbered fleet commanders (Commanders of the Second, Third, Sixth, and Seventh Fleets, assist Fleet CINCS in maintaining operational C2 over deployed naval forces within each theater of operations. For example, if a CVBG was enroute from its home ports in the U.S.

to join the Sixth Fleet located in the Mediterranean Sea, the Second Fleet Commander would maintain operational control over the CVBG as it crossed the Atlantic Ocean. Once the CVBG reached the Straight of Gibraltar, the operational control of the CVBG would then be "chopped" or transferred to the Sixth Fleet Commander. [Ref. 11]

A CVBG forms the basic naval operational force organization at sea. It is composed of many different classes of ships, aircraft, and submarines, as shown in Tables 2 and 3. Their actual composition depends on their assigned mission and the

TYPE OF VESSEL	PEACETIME QUANTITY	WARTIME QUANTITY
Ammunition and oiler support ship (AOE, AE or AO)	1	2-4
Carrier (CV/CVN (nuclear))	1	2-4
Cruiser (CG/CGN (nuclear))	1-2	4-8
Submarine (SSN)	1-3	3-4
Destroyer (DDG) or Frigates (FFG), with guided missiles	2-3	4-8
Assigned Airwing	1	2-4

Table 2. Notional Carrier Battle Group Configuration. [Ref. 8: p. I-1-2]

tactical situation. Although amphibious forces closely support missions assigned to CVBGs, they typically maneuver separately from the CVBGs. Amphibious forces and their operations will be discussed in more detail in Chapter IV. All CVBGs and other naval forces operating collectively in a predetermined area of operation are

AIRCRAFT TYPE	QTY	AIRCRAFT TYPE	QTY
F-14 Strike aircraft	20-22	EA-6 Early Warning	5
F/A-18 Strike aircraft	22	E-2 Early Warning	5
A-6 Strike aircraft	12	SH-3/H-60 ASW/Logistic Support	6
KA-6 Air tanker	4	S-3 ASW/Tanker	4

Table 3. Notional Air Wing Composition. [After Ref. 8: p. I-1-5]

assigned to a numbered fleet commander. Some CVBGs within a numbered fleet may be grouped with other CVBGs to accomplish specific missions. Two or more CVBGs organized for these specific missions typically form a task force. Generally, a task force serves as the naval component for a larger Joint Task Force (JTF). The commander of the Naval Task Force is typically a CVBG commander or the numbered fleet commander himself. If a specific mission calls for a smaller Naval Force, subsets of units from several CVBGs may be detached as part of a task group or smaller task element. A task group or task unit commander is typically designated CVBG commanders or commanding officers of individual ships. Task force or task group commanders normally assume duties as Officers in Tactical Command (OTC) and as Composite Warfare Commanders (CWC). [Ref. 11]

The OTC plays an important role in maintaining the 'big picture" of the tactical operations to insure naval forces, under his command, accomplish their primary mission. Composite warfare commanders, designated under the CWC concept, assist the OTC by conducting specific combat operations such as anti-air warfare (AAW), antisurface (ASUW), antisubmarine warfare (ASW), strike warfare (STW), and space and electronic warfare (SEW). Although the OTC and

the CWC may be different commanders, normally they are one in the same. [Ref. 8: p. I-1-13]

Figure 6 shows how the five warfare commanders are normally organized by functional areas that include: AAWC, ASUWC, ASWC, STWC, and SEWC. The warfare area commanders are chosen from the CVBG commander's staff or from commanders of ships assigned to his CVBG. They are chosen based on their personal qualifications and the capabilities of the ships they command. For example, the commanding officer of the most capable AAW platform in the task unit or task group is typically designated as the AAWC. Depending on the authority delegated to him by the CVBG commander, he may have full authority to direct and control air defense systems and ship-based weapons in the CVBG to attack an approaching enemy aircraft. It is important to note, that the CWC always retains the negation authority over his warfare area commanders. That is the

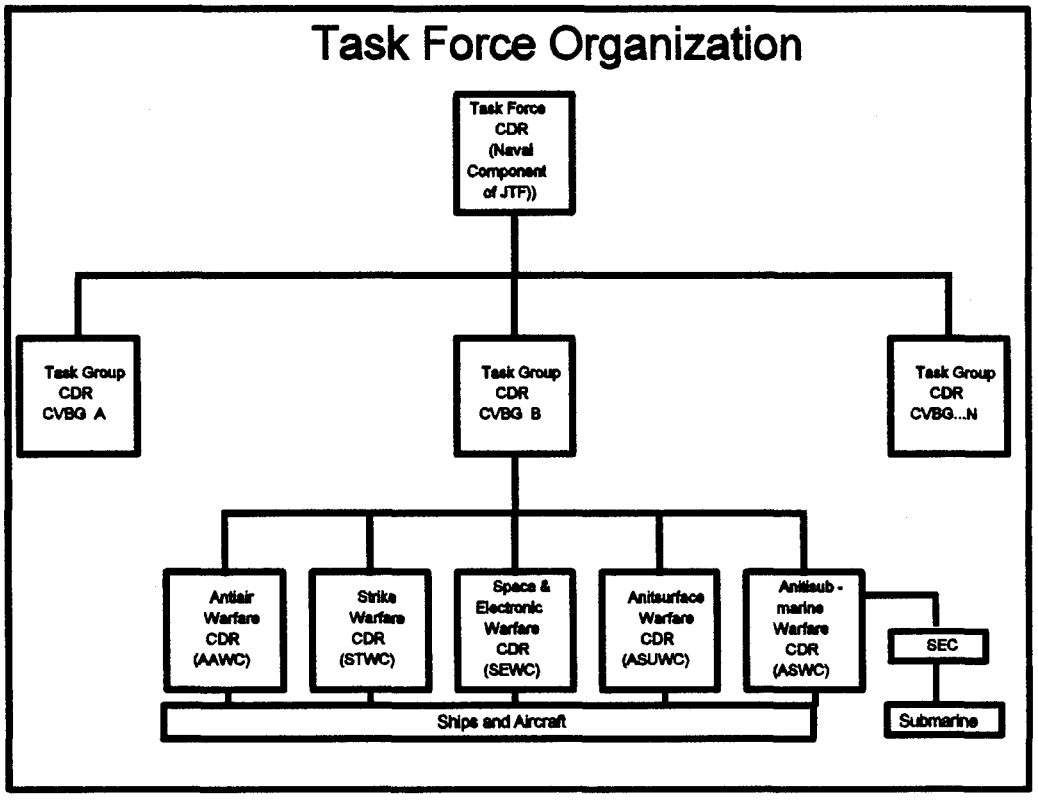

Figure 6. Task Force Organization. [After Ref. 4: Figure I-1-4]

authority to override or cancel any directive initiated by warfare commanders. To assist the CWC and the warfare commanders, the CWC assigns warfare area coordinators to manage five key support roles. These roles are: submarine element coordinator (SEC), who manages the support for submarines; the air resource element coordinator (AREC), who manages the disposition of carrier aircraft; the battle group logistics coordinator (BGLC), who manages required logistical support; the force over-the-horizon tracking coordinator (FOTC), who manages over-the-horizon tracking and surveillance of the battlespace; and the helicopter resources element coordinator (HREC), who manages the disposition of helicopters within the force. [Ref. 8: p. I-1-13]

While performing its overall mission, a task group may need to detach one or more ships or submarines from the group to conduct another mission or task. These vessels typically form a task element that is sometimes called a Surface Action Group (SAG). Once the task element completes its mission, it returns to the task group. The use of task elements prevents distractions from a task group's primary mission. For example, a task group enroute to conduct a naval blockade suddenly detects a hostile submarine operating nearby. The task group commander, may elect to form a task element, composed of two frigates and ASW capable aircraft, to identify and destroy the submarine while the remaining vessels continue toward the main objective. To lead this task element, the task group commander may appoint one individual ship commander as the task element commander. Once the task element completes its mission, it would rejoin the task group. [Ref. 11]

There are several important reasons why the Navy uses such a flexible C2 structure. The Navy has a variety of modern ships and submarines, with diverse and in many cases overlapping capabilities, that require coordination and synchronization to maximize their combat effectiveness. The CVBG can best

achieve this by structuring their C2 process based on specific functions, such as antiair, antisurface, antisubsurface, and strike warfare. The second reason for the Navy's seemingly complicated C2 structure, is to capitalize on the "power down" concept for decision-making and execution of orders. By using a C2 structure based on functionality, warfare commanders at the lower levels have the freedom to access the tactical situation, make real-time decisions, and quickly disseminate orders for execution. As discussed in Chapter I, history has shown repeatedly, that forces having the quickest decision-making C2 cycle, often achieved a decisive advantage over their opponent.

C. FUNDAMENTAL AND SUPPORTING TASKS

As mentioned earlier, the Navy must perform three basic roles that include sea control, power projection, and sealift operations. This requires the completion of many fundamental and supporting tasks. Tables 4 and 5 show a list of these fundamental and supporting tasks, their purposes, and the primary assets they require. The size of force and the tactical scenario both determine whether one or all of the tasks listed in the tables will be used to support the Navy's primary roles.

D. BATTLE GROUP OPERATIONS

The carrier battle group is the basic organization the Navy uses for its deployed forces. The aircraft carrier is the centerpiece of this organization. This vessel plays an important part in projecting the Navy's military power over great distances from the carrier battle group (CVBG). Its key functions are to provide a mobile airfield from which to launch strike or reconnaissance aircraft and to provide the C2 facilities for the CVBG commander. The C2 facilities give the CVBG commander the ability to control other ships, submarines, and aircraft

within the group and coordinate with higher authorities, as well as, other naval, joint, or combined forces. [Ref 8: p. I-1-21]

TASKS	PURPOSE	TARGET EXAMPLES	PRIMARY SYSTEMS USED
Anti-air Warfare (AAW)	Destroy and neutralize airborne threats to gain air superiority	missiles, aircraft, missile launching platforms (including air, subsurface, and surface)	Aegis Cruisers, Arleigh-Burke Destroyers, F/A Fighters, E-2C
Antisubmarine Warfare (ASW)	Destroy enemy's subsurface threats	submarines (nuclear, diesel, attack, littoral)	attack submarines, fixed wing aircraft (P-3, S-3), specially equipped helicopters (SH-60, SH-2), destroyers, and frigates
Antisurface Warfare (ASUW)	Destroy or neutralize enemy's surface naval threat to gain sea superiority	merchant ships, combat vessels, and patrol craft	destroyers, frigates, cruisers, strike aircraft (A-6, F-16, F-18), SH-60, attack submarines, P-3 and E-2C aircraft
Strike Warfare (STW)	conducting attacks, raids, or assaults on land targets	C2 centers, support facilities, ammo storage areas, airfields	strike aircraft (A-6, F-14, F-18), E-2C naval gunfire and guided munitions from cruisers, destroyers, frigates, and submarines.
Amphibious Warfare	delivery and fire support for amphibious land operations.	shore bombardment, naval gunfire support, close air support	strike aircraft, gunfire support (cruisers, destroyers, and frigates), landing ships (LPD, LSD, LST, LCAC), helicopter carriers (LPH, LHD, LHA)
Mine Warfare	offensive and defensive operations associated with employing or removing mines to allow freedom of movement within the battlespace.	offensive: mine laying, defensive: breaching mined areas through destruction and detection.	MH-53 helicopter
Space and Electronic Warfare (SEW)	operations to protect friendly use of the electromagnetic spectrum while denying its use to the enemy.	identification, location, and destruction of enemy signal emitters, jamming, interception, deception,	all electronic warfare systems aboard ships, submarines, and aircraft

Table 4. Fundamental Tasks. [After Ref. 8: pp. I-1-11, I-1-18, and I-1-23]

TASKS	PURPOSE	EXAMPLES	PRIMARY SYSTEMS USED
Special Warfare	deploying special operating forces to perform unconventional warfare, and reconnaissance operations	intelligence gathering on enemy activities in littoral regions, sabotage of C2 centers and support facilities	submarines, helicopters (CH-53, CH-46)
Ocean Surveillance	surveillance of named areas of interest to identify and locate surface, subsurface, and airborne enemy targets	detection and location of hostile submarines, aircraft, ships/crafts operating near the tactical areas of interest	surveillance aircraft (E-2C, P-3, S-3), submarines, cruisers
Command, control, and communications	install, operate, and maintain C2 systems required to plan, direct, and control assigned forces	communication centers and facilities, C2 personnel, procedures	shore based command centers, carriers, amphibious command ship (LCC), and other command ships (AGF), E-2C and P-3 aircraft
Logistics	provide supplies and maintenance support to deployed forces (all services)	fuel, ammunition/ordinance, parts, maintenance services, food	underway replenishment ships, oilers, (AOE, AOR, AO and AE), air tankers (KA-6), cargo helicopters (CH-53, CH-46)

Table 5. Supporting Tasks. [After Ref. 8: pp. I-1-12 to I-1-24]

Figure 7, centered on the carrier, shows a generic representation of the displacement and areas of responsibility for other ships that make up a CVBG. Since aircraft carriers have limited self-defense capabilities, they must rely on other units in the CVBG for protection. Figure 7 also shows that cruisers operate within approximately 10 miles of the carrier and provide an inner barrier of defense against air, surface, and subsurface attacks directed at the carrier. These ships are equipped with state-of-the-art weapon systems and target tracking

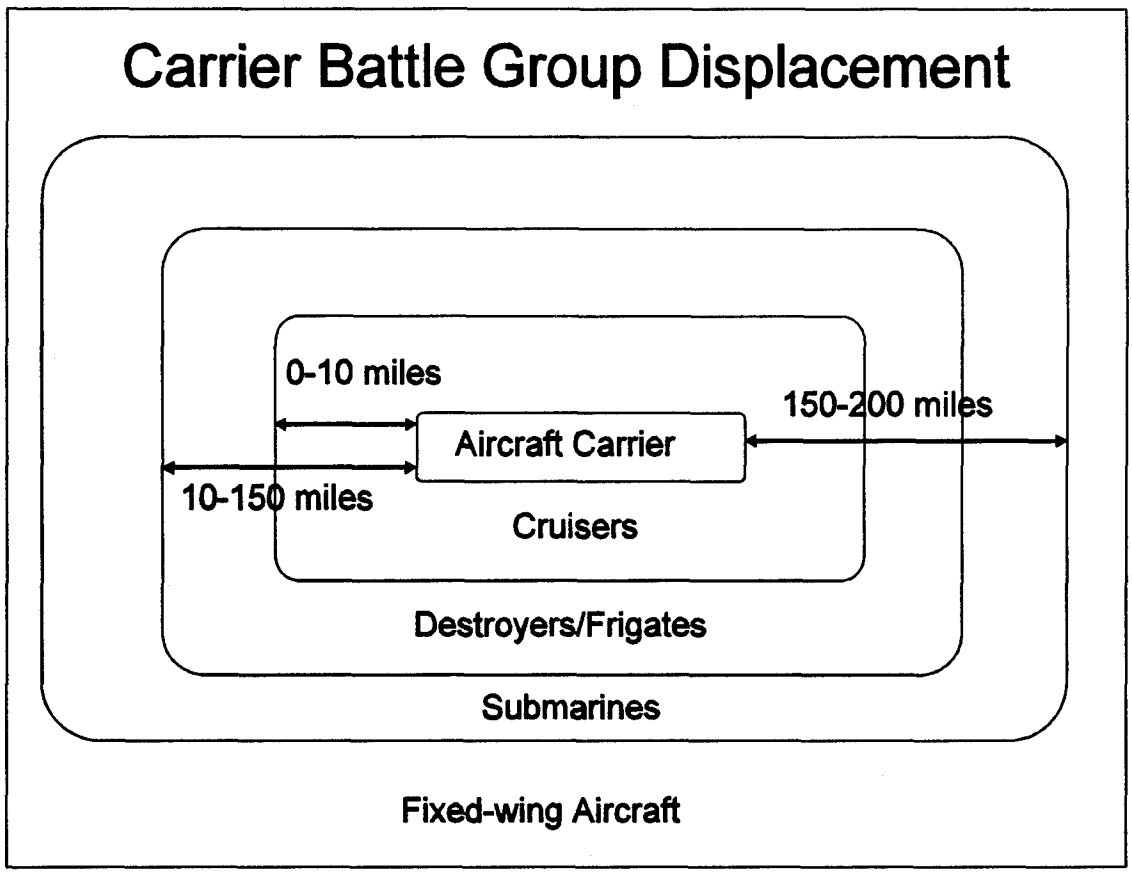

Figure 7. Battle Carrier Group Displacement. [Ref. 4:p. I-1-20 and Ref. 6]

systems to facilitate this role. SH-60 Helicopters, armed with homing torpedoes, work with other fixed wing aircraft to strike surface and subsurface targets. The helicopters normally operate within visual range of the CVBG. The destroyers and frigates typically operate in regions from 10-150 miles from the carrier to screen the CVBG against surface, air, and subsurface threats. It may perform other missions, as well, such as providing naval gunfire support to amphibious landing forces or other joint operations ashore. Submarines assigned to CVBGs are responsible for the regions 150 miles or more from the carrier. The CVBG commander or the antisubmarine warfare commander may designate submarines to perform a variety of missions such as reconnaissance, antisubsurface, and antisurface operations. Fixed wing aircraft, launched from either shore bases or

the aircraft carrier, extend the eyes of the CVBG commander 75-200 miles or more on the flanks or ahead of the CVBG. These aircraft search for hostile submarines, aircraft, and surface vessels by using visual sightings, in conjunction with, radar and sonar systems. [Ref. 8: pp. I-1-20 to I-1-21 and Ref. 11]

Specific missions, areas of responsibility, and tactical displacements of each vessel within a CVBG, depend greatly on the composition of the CVBG and the tactical scenario. For instance, if the CVBG is operating in a confined area, like the Persian Gulf, it may have ship displacements far less than the distances shown in Figure 7. Conversely, if the CVBG is crossing the Atlantic Ocean, ship displacements may be much greater.

E. NAVY LIMITATIONS

The Navy inherently has several limitations, such as sustainment capabilities and carrier mobility during flight operations. In order for the Navy to maintain a ship (of a specific type) continously on station for an extended period of time, they often must consider a ratio of three ships to one. This means that for every ship (of a specific type) required to remain on station, three ships must be designated for the mission. This is generally the result of one ship being in port (maintenance), while another is in transit to the region, and the third is the ship actually performing the assigned mission. The Navy's ongoing modernization iniatives to procure multi-functional ships will assist the Navy to overcome this limitation.

The aircraft carrier may provide significant contributions to the CVBG with its typical 78 aircraft, however, it must overcome several that are unique to its role. Some of these limitations are the mobility of the carrier when launching or recovering aircraft, required crew rest that reduce available flight hours, equipment maintenance, and logistics (fuel, ordinance). When aircraft are being launched or

recovered, the aircraft carrier must turn into the wind, forcing it to slow down or change direction. Furthermore, scheduled maintenance requirements and a finite amount of fuel and ordinance onboard limit its ability to sustain high intensity flight operations for long periods of time. The CVBG commanders must consider these limitations when planning and executing assigned missions, so they can preserve their equipment and personnel. [Ref. 8: pp. I-1-21 to I-1-22]

F. NAVAL WARFIGHTING PHILOSOPHY

The understanding of naval warfighting philosophy provides insight, in a broad sense, on how the Navy plans and executes its assigned missions. The Navy's warfighting philosophy centers on two styles of warfighting: attrition and maneuver. Attrition warfighting philosophy is a direct approach that involves concentrating friendly resources to attack an enemy's primary offensive capability. Favorable outcomes using this type of philosophy, generally require force on force operations and many resources such as time, personnel, equipment, and ammunition. Alternately, maneuver warfighting philosophy is an indirect approach of using maneuver strategies and concepts to exploit known enemy weaknesses and vulnerabiliteis. [Ref. 9: pp. 31-32]

The *Naval Doctrine Publication 1 (Naval Warfare)* used the Battle of the Atlantic in World War II to illustrate an example of attrition warfare. During this battle, allied forces identified U-boats as Germany's principle and most effective capability at sea. After the allies experienced significant losses of their surface vessels, they redirected a substantial amount of supplies, equipment, and personnel toward subsurface warfare. Consequently, this approach lead to the attrition of the Nazi U-boat Fleet before the German's industrial base could build additional vessels. In this situation, attrition style warfare proved to be an effective tool that permitted allied forces to regain sea superiority. Although history has shown that

attrition warfare can produce the intended results, it only occurs at the expense of significant resources thus limiting other simultaneous operations. [Ref. 9: pp. 32-33]

Advancing technology and sophisticated weapons, like the long range cruise missile, have encouraged the Navy to favor the maneuver warfighting philosophy. Today's Navy commanders have better access to information about the enemy situation as a result of improved sensors and C2 information systems. This allows them to quickly identify specific enemy capabilities and vulnerabilities. Examples of these capabilities include enemy troop displacement, key C2 facilities, and supply routes. The main idea of maneuver warfare is to attack critical, but vulnerable, enemy capabilities needed to conduct or sustain offensive operations. This allows the Navy to avoid the enemy's main strengths and simultaneously preserve its own resources.

Naval commanders may elect to use either or both warfighting philosophies when developing operational plans. They integrate these philosophies into their plans by considering nine *Principles of War* that support the Navy's warfighting doctrine.

G. PRINCIPLES OF WAR

The principles of war provide a sound doctrinal framework for navy commanders to formulate their operational plans in a dynamic and fast-paced combat environment. Since the Navy's C2 architecture and organization promote decision-making at the lowest possible level, the principles of war add a thread of continuity to this process. The nine principles of war are based on proven concepts used throughout military history and include objective, mass, maneuver, offensive, economy of force, unity of command, simplicity, surprise, and security. [Ref. 9: pp. 43-50]

Objective is a clearly defined goal of the mission necessary to satisfy the commander's intent. Examples of stated objectives are: [Ref. 9: p. 44]

- Secure specific seaport(s).
- Conduct a naval blockade around a designated area.
- Destroy the enemy's rear lines of communications.

Unity of command is the common orientation of applied effort by the complete chain of command. This effort is achieved by clearly understanding the primary objectives that are outlined in the commander's intent [Ref. 9: p. 46]. This gives commanders and their staffs at the lowest level the freedom to use their tactical expertise in developing their own concept of operations to accomplish their mission. For example, the commander of the Sixth Fleet might assign one of his task group commanders to secure a specific port critical to the success of a larger JTF operation. Although the task group commander is given a specific mission, he has the flexibility to develop his own concept of operations, in order to, accomplish the mission. By securing the port, the task group has contributed to the JTF's unified objective.

Mass is concentrating the magnitude and direction of a force's combat power toward a selected objective or enemy force to exploit his vulnerabilities or weaknesses [Ref. 9: p. 44]. Since the massing of combat power requires tremendous resources, it normally supports the direction of the main effort, such as the primary objective for a regional campaign.

Maneuver is the moving or disposition of naval forces that allows maximum destruction of enemy capabilities while simultaneously offering protection to friendly forces [Ref. 9: p. 45]. The maneuver principle facilitates the Navy's maneuver warfighting philosophy, by avoiding the enemy's strengths and attacking

his weaknesses. Furthermore, this principle is the means by which the Navy integrates other principles of war like mass, offensive, economy of force into their concept of operations.

The *offensive* principle is the employment of tactics to seize and maintain the initiative of combat operations [Ref. 9: p. 45]. This principle is a prerequisite for achieving decisive victory over hostile forces. In a JTF campaign for instance, the Navy may provide initial volleys of overwhelming firepower to soften the enemy land forces, prior to army or marine units conducting follow-on land operations.

The *economy of force* principle is the displacement of friendly forces that reduces the number of forces required to protect friendly vulnerabilities and allows the majority of combat power to be used in support of the main effort [Ref. 9: p. 46]. The Navy may also use this principle to distract enemy forces away from the direction of their main objective, to avoid direct force on force confrontation against the enemy's strengths.

The *simplicity* principle means to define mission objectives and plans in concise terms so that commanders clearly understand their roles and expectations [Ref. 9: p. 46]. By minimizing ambiguities or chances for misinterpretation, commanders at the lower levels enjoy the freedom to modify their own plans to cope with the complex and rapidly changing nature of combat.

The *surprise* principle is geared toward attacking enemy forces from directions where they are unprepared to defend or at times when they least expect [Ref. 9: p. 47]. The main idea of this principle is to catch enemy forces "off-guard" in which they have little time to prepare counteroffensive operations. The Navy plays an important role in exercising this principle, especially in support of joint operations, due to their forward presence in the region. For example, a CVBG can strike enemy sea or shore targets from virtually anywhere and from any

direction in the region, by using their carrier based aircraft and precision guided missiles. This unique capability gives friendly forces a superb advantage to conduct surprise raids or shore bombardments, in order to, exploit enemy weakness and gain the initiative.

The *security* principle is the protection of friendly operational plans, objectives, and intentions to prevent the enemy from preparing counteroffensive or evasive actions [Ref. 9: p. 47]. The security principle is essential to conducting surprise attacks on hostile forces and includes the security of communication systems, force displacement, and friendly capabilities.

These nine principles of war are embedded into today's navy doctrine. Commanders and staffs should carefully consider them before developing their concept of operations. These principles form a baseline to facilitate planning and execution of orders in a dynamic and unpredictable combat environment.

H. SUMMARY

The U.S. Navy provides the NCA and CINCs with a prepositioned, self-sustaining, combat-ready force, for which they can call upon to rapidly enforce foreign policy, protect our interests abroad, or respond to international crises. To support these national objectives, the Navy must perform three primary roles that include sea control, power projection, and sealift operations. The Navy's operational forces further divide each of these roles into specific fundamental and supportive tasks. These tasks assist in planning and executing their assigned missions. To manage and support the fundamental and supportive tasks, the Navy has a C2 structure that consists of administrative and operational chain of commands.

The CVBG forms the basic organization for deployed forces that commanders can further divide into task groups or elements to perform specific

missions. The heart of the CVBG is the aircraft carrier. The composition of aircraft onboard the carrier gives the CVBG commander a wide range of military options. Since the carrier has only a limited number of defense systems onboard, it must rely on other vessels in the CVBG to protect it from air, surface, and subsurface threats. The displacement of these vessels, ranging from a few miles to several hundred miles, introduces special considerations when planning naval C2 support systems.

As presented in this chapter, much of the Navy's C2 structure, under the CWC concept, is geared toward decentralized execution of tasks at the lowest possible level of command. This type of C2 structure give commanders a significant degree of freedom to integrate the nine principles of war into their operational plans and accomplish their mission.

IV. U.S. MARINE CORPS MISSIONS, ORGANIZATION AND PHILOSOPHY

The previous chapter introduced the Navy's purpose, organization, and warfighting philosophies. Using the same approach, this chapter provides a similar overview for the U.S. Marine Corps. The specific goals of this chapter are to answer the following questions: What are the primary and secondary roles of the U.S. Marine Corps? How does the Marine Corps organize and deploy its forces? What is the Marine Corps warfighting philosophy? The answers to these questions continue to build the foundation for understanding the types of C4I systems found in each branch of service, as well as, their operational uses. The Marine Corps' C4I systems will be presented later in Chapter VIII.

A. MARINE CORPS MISSIONS

The U.S. Marine Corps primary mission is to provide a forward-deployed Naval Task Force with highly trained and combat ready Fleet Marine Forces. These forces are capable of conducting combined-arms operations ashore to support the prosecution of naval, land, or joint campaigns. Fleet Marine Forces give the NCA the ability to demonstrate a show of force to aggressive nations, without the U.S. physically landing the military on foreign soil. In addition, Fleet Marine Forces demonstrate the nation's resolve to protect global interests and enforce international law. [Ref. 8: p. I-2-3]

At the lower levels of command, the Fleet Marine Forces give CINCs and naval fleet commanders immediate access to expeditionary forces that are capable of seizing or defending advanced naval bases, sea ports, and other facilities. Some examples of typical marine missions include; amphibious operations, advanced naval base defense, limited collateral land operations with army units, reconnaissance or intelligence operations, aerial refueling support, and land and

sea-based air operations. The type of assigned missions depend on the level of conflict as shown in Table 6. The three levels that constitute the spectrum of conflict are Low Intensity Conflict (LIC), Medium Intensity Conflict (MIC), and High Intensity Conflict (HIC). [Ref. 8: pp. I-2-2 and I-2-15]

LICs generally require active marine forces to perform a broad range of economic, political, and military activities [Ref. 12: p. 4]. These activities can be categorized as either limited objective operations or stability operations. Conflicts against well organized and larger threats are called MIC. At this level, active marine forces perform conventional combat operations or activities in preparation for a HIC. HICs require both the active and reserve marine force components to participate in large scale land and naval campaigns against one or more sizeable threats. [Ref. 8: p. I-2-15]

In addition to their primary missions stated in the preceding paragraphs, Public Law 10 of the U.S. Code, mandates that the Marine Corps is responsible for performing other secondary roles. These secondary roles are as follows:

- Act as the lead service in developing tactics and doctrine related to amphibious operations
- Provide marine detachments onboard armed naval vessels to protect and secure advanced navy facilities
- Prepare and integrate marine reserve components into the active component force structure to facilitate transitions to war, or respond to national emergencies and international crises. [Ref. 8: p. I-2-15]

B. MARINE CORPS ORGANIZATION

The basic building block of the Marine Corps organization is the Marine Air Ground Task Force (MAGTF). These forces provide combatant commanders

LOW INTENSITY CONFLICT (LIC)		MEDIUM INTENSITY CONFLICT (MIC)	HIGH INTENSITY CONFLICT (HIC)
Stability Operations	Limited Objective Operations	Conventional Combat Operations	General War
Show of Force Humanitarian Assistance Ops - Deliberate Ops - Disaster Relief - Civil Action Ops Mobile Training Teams Assist. Ops Security Ops Peacekeeping Ops Counter-narcotics Ops Counter-insurgency Ops	Peacetime Contingency Ops - Noncombat Evacuation Ops (NEO) - Amphibious Raid - Seizure - Reinforcement - Tactical Rescue of Aircraft and Personnel (TRAP) Counter-terrorism Ops	Amphibious Ops - Surprise Attacks - Helicopter lift Ops - Deep Recon. - Offensive Air - Sea-based Support Special Ops - Raids - Strikes Operations Ashore - Reinforcements - Support Land Campaigns - Independent Actions - Interoperability	Amphibious Ops - OTH Helicopter Ops - Assault Ops Operations Ashore - Reinforcements - Support Land Campaign - Independent Actions - Interoperability - Reserve land force

Table 6. Marine Corps Missions. [After Ref. 4, Figure I-2-14: p. I-2-1]

with a balanced, combat-ready, combined-arms force needed to support specific missions. A MAGTF is not a permanent organization and usually dissolves after completing its assigned role. The decision to organize and commit MAGTFs in response to a combatant commanders' or CINCs' operational tasking, rests with the

Commanding General, Fleet Marine Force Pacific, Atlantic or Europe. MAGTFs may work either independently or as a member of a joint or combined force, to support the prosecution of land or naval campaigns. They are organized normally structured to facilitate rapid sea or air mobility to their theater of operation. Additionally, MAGTFs are self-sustaining, thereby eliminating the need for host nation support. MAGTFs consist of three components: Command Element (CE), Ground Component Element (GCE), Air Component Element (ACE), and a Combat Service Support Element (CSSE). [Ref. 8]

The CE is the single headquarters for the MAGTF consisting of the commander, an executive staff, and a special staff. They are responsible for providing C2 and direction over the planning, coordination, and execution of all missions assigned to the MAGTF. The CE also contains all communications facilities that permit the MAGTF commander to coordinate with higher, lower and adjacent commands. [Ref. 13: p. 2-2]

The GCE consists of infantry and armor units, varying in size from smaller than a battalion to multiple divisions. In addition, the GCE consists of other organic combat and combat service support units required to sustain ground operations. [Ref. 13: pp. 2-2 to 2-3]

The ACE consists of the air assets in the MAGTF, along with its associated air control agencies, organic combat support units, and combat service support units needed to support these aircraft. Some of the functions performed by the ACE are close air support (CAS), air reconnaissance, anitair warfare, and air traffic control. [Ref. 13: p. 2-3]

The CSSE supports the MAGTF with additional services beyond those which are provided by organic combat service support units within the GCE and ACE. Some of these services include supply, maintenance, engineer, medical/dental, military police, food, and financial services. [Ref. 13: p. 2-3]

Normally there is only one CE, GCE, ACE, and CSSE within each MAGTF. The MAGTF and supporting units are organized to support specific objectives and will vary in size from one MAGTF to another depending on their assigned mission. [Ref. 13: p. 2-3]

Marine forces are typically under the operational command of a unified CINC. These commanders exercise their operational C2 over Marine forces as shown in Figure 8. When operating in a joint environment, MAGTFs can be employed as: [Ref. 8: p. I-2-23]

- A service component of the Naval component under a unified command
- An element of a joint task force under a unified command

In the planning phases, the MAGTF is under the command of the CG, Fleet Marine Force Atlantic, Pacific or Europe [Ref. 13: p. 1-8]. As the operation moves into the execution phase, operational control shifts over to the operational command structure depicted in Figure 8. The roles of the Commander of the Amphibious Task Force (CATF) were discussed in Chapter IV.

The CATF is responsible for the over all operations concerned with the MAGTF's transition form ship to shore and their C2 facilities. Once the force establishes their C2 facilities on shore, the CATF hands over the C2 to the Commander of the Landing Force (CLF). The CLF then maintains the C2 over all ground and air assets operating in his area of responsibility. During redeployment of the MAGTF, the above procedure simply works in reverse. [Ref. 14: p. 115-117]

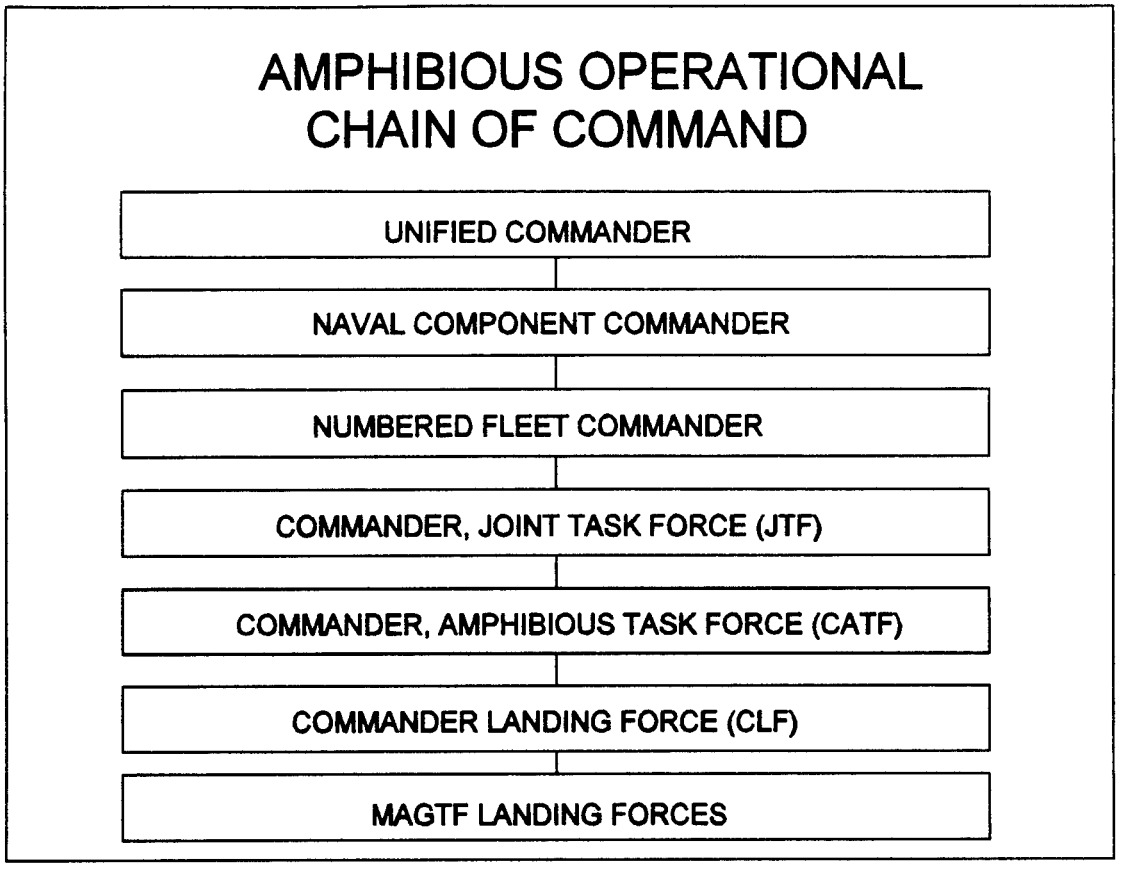

Figure 8. Amphibious Operational Chain of Command. [After Ref. 14: p. 116]

C. TYPES OF MAGTFS

There are four types of MAGTFs commonly used to fulfill the Fleet and CINC commander's goals and objectives. These are the Marine Expeditionary Force (MEF), the Marine Expeditionary Brigade (MEB), the Marine Expeditionary Unit (MEU), and the Special Purpose forces (SPF). Table 7 shows the notional composition of each type of MAGTF. [Ref. 8: p. I-2-7 and Ref. 13: p.1-3]

FORCE ASSETS	MEF	MEB	MEU
Marines and Sailors	30,000-60,000	4,000-18,000	1,000-4,000
Aircraft Organizations (Marines)	1-2 Air Wings	1-2 Air Groups	1-2 Air Sqdns
Service Support Groups (Size)	Force	Brigade	Unit
Divisions or Battalions	1-2 (Divisions)	2-5 Inf Bn	1-2 Inf Bn
Amphibious Ships	44-56	15-21	4-7
Tanks	70-140	17-34	5-10
Helicopters	250-300	75-120	20-36
Medium and Heavy Artillery Pieces	75-100	24-42	6-12
Tactical Fixed Wing Aircraft (USMC)	125-175	45-65	USN/USMC (as available)
Amphibious Assault Battalions/Vehicles	1-2 (Bn)	20-30 (Veh.)	10-15 (Veh)
Carrier Air Wings (USN)	2-4	1-2	0
* Note: Composition for SPF was omitted, due to the large diversity between each organization.			

Table 7. Notional MAGTF Composition. [Ref. 8: pp. I-2-7 to I-2-9]

The MEF is the largest and most powerful MAGTF. It's size ranges from slightly less than one division and a single air wing to several divisions and multiple air wings. The MEF is task organized to conduct a wide range of amphibious assault operations, operate in diverse environments, and sustain combat operations for about 60 days. Depending on its actual size, the MEF is

normally commanded by a major or lieutenant general. [Ref. 8: p. I-2-7 and Ref. 13: p. 1-3]

A MEB is typically composed of a regimental size ground force and a aircraft group. In addition, it contains a brigade size combat service support element that is capable of sustaining combat operations for about 30 days. This organization is usually commanded by a brigadier general. [Ref. 8: p. I-2-11 and Ref. 13: p.1-3]

The MEU, normally commanded by a colonel, is composed of a reinforced battalion, a helicopter squadron, and service support units. Although fixed-wing aircraft support may be provided to the MEU when requested by the MEU commander or directed by higher authorities, these aircraft are usually not part of the organization. MEUs are designed primarily to support routine afloat operational requirements. Even though MEUs are limited in size and capability, they provide suitable quick reaction forces to fleet commanders. Generally they will not operate as a separate amphibious assault force, but as the leading element for a larger MEB or MEF. Seabases, positioned nearby, sustain the MEU for a period of about 15 days without being reinforced or resupplied. [Ref. 8: p. I-2-9 and Ref. 13: p. 1-3]

A special type of MEU called Marine Expeditionary Units with Special Operating Capability (MEU SOC) are forces augmented with special equipment and specialized training needed to perform unique marine operations associated with LICs. Although these forces have special operations capabilities, they are not considered special forces. Examples of MEU SOC missions are amphibious raids, security operations, show of force, mobile training teams, civic actions, and hostage rescue. [Ref. 8: p. I-2-9]

The SPF is a task organized force composed of highly trained marines and specialized equipment to accomplish particular missions. The members have

received extensive training in reconnaissance operations, intelligence collection, day/night operations, and small independent unit tactics. This type of training distinguishes them from the members of the MEU (SOC) units. SPF may deploy to their area of operations by amphibious ships, commercial ships, or military aircraft. Their primary purpose is to give the fleet and combatant commanders a unique and highly trained force capable of performing missions that the MEFs, MEBs, MEUs are not structured, trained, or equipped to accomplish. [Ref. 8: p. I-2-10]

D. METHODS OF MAGTF DEPLOYMENT

Since MAGTFs vary greatly in their size and capability, operational commanders consider four methods for deploying MAGTFs to an area of operations. These methods are forward basing, sealift/sea-basing, pre-positioning, and airlift. [Ref. 8: p. I-2-13]

Forward basing refers to the strategic placement of MAGTFs at land bases near their assigned geographical area of interests. This type of deployment minimizes the air assets, sealift assets, and deployment time necessary to insert MEF size forces into threat areas. [Ref. 8: p. I-2-13]

Sealift/sea-basing is the forward placement or movement of a MAGTF to or within their projected area of operations using their organic amphibious ships. Typically MEBs and MEFs are forward deployed on these vessels. Their support is provided by other amphibious ships within the ATF or MEF. For example, A MEB may be formed and forward deployed in their amphibious vessels to selected areas, as political tension builds between the U.S. and some uncooperative nation. If political and economic sanctions fail to achieve their goal, the MEBs offer the combatant and fleet commanders the combined-arms force needed to support U.S. military intervention. Once the MEB arrives in their area of operations, they will

loiter in the region until required or directed to move ashore. During land operations requiring a MEF size force, a MEU may act as the lead element as shown in Figure 9. Once the MEU becomes established, it will then building a

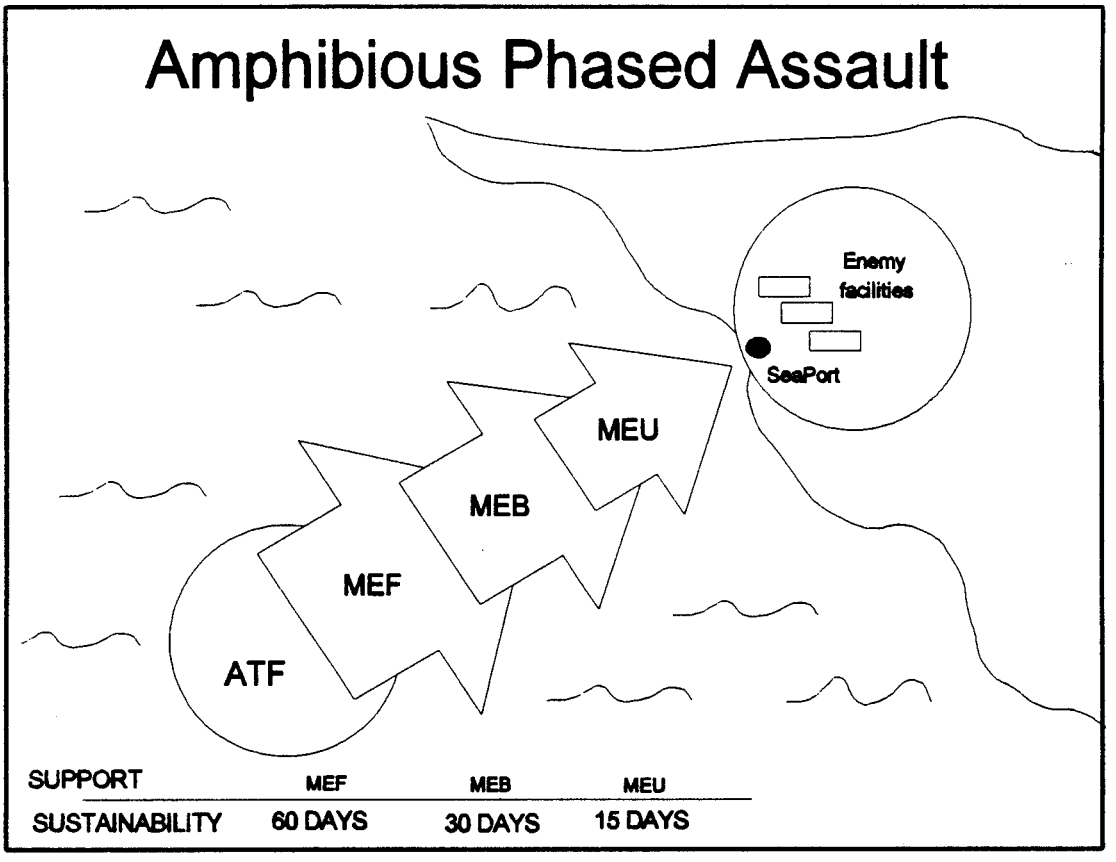

Figure 9. Amphibious Phased Assault.

MEB as additional forces transition ashore. The MEB, similiar to the MEU, will serve as the lead element and begin building the MEF as it moves ashore. The principal advantages of this type of deployment is to minimize U.S. presence in the country while simultaneously equipping fleet commanders or CINCs with quick reaction forces capable of initiating land operations. [Ref. 8: p. I-2-14]

During an amphibious operation, the MEF may conduct an over-the-horizon assualt. This type of assault integrates the mobility provided by modern

helicopters into a landing forces' scheme of maneuver. Additionally, this allows the amphibious ships to remain at safe stand-off distances from hostile artillery, without hindering the speed of the landing force.

Pre-positioning is the placement of equipment onboard marine pre-positioning ships (MPS) required to outfit a MEF and sustain combat operations for a period of 30 days. Generally, sailors and marines of the MEF are airlifted from the continental U.S. to secure staging areas where they will link up with their equipment and prepare for further employment into their area of operations. [Ref. 8: p. I-2-14]

Airlift deployment is the rapid deployment of airmobile MEBs, commonly referred to as Air Contingency Forces (ACF), using strategic airlift assets. MEBs may be either airlifted directly to their area of operation or airlifted to staging areas where they will be supplemented with additional pre-positioned equipment. Airlift deployments provided a means to rapidly deploy a MEB, but unless these forces are matched with pre-positioned equipment, their capabilities may be limited. [Ref. 8: p. I-2-14]

The fleet marine force commanders may elect to use one or a combination of the methods of MAGTF deployment to respond to global threats in their area of responsibility. In the event the fleet marine commander requires a large MEF, he will typically use a "building block concept" to insert the force. Figure 9 illustrates this concept by showing a MEU acting as the lead element for a MEB moving ashore. As the MEB completes its transition to shore, it continues to build the size of the force by accommodating the remaining elements of the MEF. [Ref. 8: p. I-2-12]

E. WARFIGHTING PHILOSOPHY

Warfighting philosophy in the U.S. Marine Corps is based on three ideas that include command philosophy, shaping the battle, and maneuver warfare. The dynamics of land warfare require the marine corps to promote an aggressive command philosophy that gives commanders the authority to employ decisive maneuver tactics necessary to produce favorable outcomes. [Ref. 15: pp. 58, 60, and 66]

Marine Corps' command philosophy, similar to the Navy, is based on the "power down" or decentralized decision making. Marine commanders are granted the freedom to make tactical decisions at the lower levels because they often have a better appreciation for immediate actions needed to respond to the tactical situation. Decentralized decision making is vital to controlling the dynamic nature of combat caused by the fast tempo, fog, and friction of battle. The term fog, used in this context, refers to uncertainty and confusion created as friendly and enemy forces try to impose their will on each other. The friction of battle is the resistance to friendly force initiatives created by hostile fire, disruption of C2 systems, and the struggle to maintain a coordinated effort using complex organizations.

The success of any decentralized C2 structure depends highly on the competence of subordinate leaders to make timely decisions, effectively use of their decision support systems, and aggressively employ offensive and counter-offensive measures. Furthermore, Marine commanders must integrate their knowledge of tactics, doctrine, command philosophy, and the commander's intent into their operational plans and decisions. They must rely on their knowledge and other personal leadership traits such as courage, initiative, imagination, and acceptance of calculated risks, to make the timely and rational decisions. The Marine Corps cannot tolerate commanders who are timid, indecisive, and weak,

since its costs are often paid in the form of human lives. [Ref. 15: pp. 4-5, 6, 61-65]

Commanders at the lower levels have a distinct advantage in detecting enemy soft spots, gaps, or vulnerabilities that must be exploited to achieve an offensive advantage and shape the forthcoming events of battle. Shaping the battle requires commanders to be adequately informed so they can modify their concept of operations, in order to, force the enemy to respond to friendly initiatives. Some examples of how a marine commander may shape the battle are: [Ref. 15: p. 67]

- Channeling enemy movement into selected areas
- Delaying enemy movement
- Isolating enemy forces from reinforcements and support.

The key to shaping battle events relies on the commanders' access to real-time intelligence of the operational scenario gained through their C2 support systems. Tactical reconnaissance operations and national sensors provide critical input to these systems. Commanders must use this information, in conjunction with their own expertise and vision, to anticipate how the enemy is likely to respond to friendly maneuver warfare.

The main goal of maneuver warfare is to strike the enemy hard and violently in areas where he least expects it and where it causes the most damage. Maneuver warfare concepts form the foundation for today's warfighting philosophy by replacing the old attrition style approach. By avoiding the enemy's main strengths, commanders preserve their resources and firepower needed elsewhere to exploit decisive opportunities. The two key components of maneuver warfare include mobility and firepower. [Ref. 15: pp. 58-61]

Today's MAGTF's have a variety of organic transport assets such as tactical vehicles, helicopters, and amphibious ships available to mobilized MAGTF forces quickly across their area of operations. The rapid mobility of a powerful, self-sustaining combat force furnishes JTF and Fleet commanders with the ability to insert or extract MAGTFs quickly at several locations. This creates confusion and uncertainty within the enemy ranks, making it hard for them to detect the MAGTF's true axis of advance. For example a JTF or Fleet commander may initially direct an amphibious task force (ATF) to more ashore to secure a specific seaport. Once secured, the ATF may return to their amphibious ships and await further taskings. Since the enemy cannot predict the MAGTF's axis of advance, the MAGTF capitalizes on several principles of war such as surprise, mass, economy of force, maneuver, and offense. Surprise is often gained by the MAGTF attacking the enemy during hours of darkness and limited visibility. By mobilizing and maneuvering their forces, commanders are able to mass their combat power at the right time and place to exploit weak or "soft" spots in the enemy defenses. Only the minimum size force is used to protect other areas of the MAGTF against possible enemy counterattacks. [Ref. 8: p. I-2-25 and Ref. 15: pp. 35-36]

Combined-arms assets such as tanks, field artillery pieces, aircraft, or supporting naval aircraft and gunfire support constitute the bulk of the MAGTF's firepower. Typically the fire support from close air support and field artillery units are employed to soften enemy targets, prior to committing infantry forces on the objective. It is important to note, that the primary purpose of firepower may not necessarily be to completely annihilate the enemy, but instead, create doubt among his forces that eventually degrades unit cohesion. [Ref. 15: p. 59]

The effective use of maneuver warfare provides MAGTF commanders with tactical opportunities to set the operational tempo, gain the offensive initiative, and

prevent the enemy from conducting evasive actions. A fast operational tempo produces delays or hasty decision making among enemy commanders. This in concert with a well-synchronized concept of operations that maximizes combat power at the right place and time, will ultimately destroy the enemy's will to fight.

F. SUMMARY

The type of missions assigned to the U.S. Marine Corps varies depending on the level of conflict. The uniqueness of the Marine Corps lies in its ability to conduct rapid amphibious operations from pre-positioned sea platforms. The MAGTF, with its combined arms capability, provides CINCs and fleet commanders with a combat ready force necessary to support the prosecution of naval or land campaigns. Regardless to its size, all MAGTFs have organizational structures tailored to accomplish specific mission requirements. MAGTFs can deploy to their areas of operation through forward basing, sealift operations, airlift operations, or pre-positioning of forces. The success of the MAGTF depends on the commander's ability synchronize his combat power at the right time and place to exploit known enemy weaknesses. This requires decentralized decision making and effective employment of sound maneuver warfare techniques, based on warfighting doctrine and philosophy. To achieve favorable outcomes, commanders must initiate actions that shape future battle events and force his enemy into a reactive posture. The result of these actions eventually leads to the degradation of enemy's force cohesion and their will to fight.

V. AIR FORCE MISSIONS, ORGANIZATION, AND WARFIGHTING PHILOSOPHY

A. INTRODUCTION

During the end of World War I, military leaders began to first recognize the value of air power in battle outcomes. The use of air power became even more predominate during World War II, as the design of military aircraft improved in range, speed, and lethality. This trend continued to the more recent Gulf War in 1991. In Desert Shield/Storm air power was used extensively by Allied Forces to destroy Iraq's C2 centers, weapon storage facilities, and produce damaging psychological effects on their forces. Today's integration of air power into combined operations, provides military leaders the capability to rapidly project combat power deep within enemy territories. More importantly, proper application of air power, gives U.S. Armed Forces the opportunity to exploit the three dimensional battle space to achieve its national, strategic and tactical objectives. [Ref. 8: p. I-4-5]

This chapter presents the modern U.S. Air Force's missions, organizations, capabilities, limitations, and warfighting philosophies support missions designated by the U.S. Code, Title 10. The objective, like the previous chapters, is to continue building an operational knowledge necessary to understanding the C4I systems required to support the air component. These C4I systems will be presented later in Chapter IX.

In order to understand the information presented throughout this chapter, the terms aerospace environment and aerospace forces needed to be clearly defined. The aerospace environment is all areas above the earth's surface to include space. Since the Air Force provides and controls the majority of the assets operating in this medium, they are commonly referred to as aerospace forces.

These forces capitalize on their use of air and space to provide them global access to any place on the earth's surface without limitations imposed by terrain or enemy obstacles. Conversely, the Air Force must contend with other obstacles, such as the enemy's aircraft and air defense weapons, to achieve air superiority. After the Air Force achieves air superiority, it can project combat power with great speed, range, versatility, and flexibility. These attributes are hallmarks of the Air Force and unparalled by the other services. [Ref. 16: p. 5]

B. PRIMARY ROLES AND MISSIONS

There are four primary roles assigned to the Air Force that include aerospace control, force application, force enhancement, and force support. Associated with each of these roles are more specific missions the Air Force must accomplish to meet its operational objectives. [Ref. 16: pp. 6-7]

Aerospace control are measures taken to gain and maintain friendly use of the aerospace environment while also denying its use to enemy forces. These measures include offensive and defensive counter air and counter space operations. Counter air refers to measures taken to achieve air superiority necessary for friendly forces to conduct air operations with acceptable friendly losses and deny the use of this medium to enemy forces. Gaining air superiority is the Air Forces first and foremost important mission. Additionally, air superiority provides the operational commander the freedom to maneuver both his surface and Air Forces effectively to achieve his objectives. Counter space operations refers to measures taken to gain and maintain sole use of space while simultaneously denying its use to our adversaries. [Ref. 16: p. 6]

Force application is the delivery of aerial combat power at the right time and place against the enemy's surface targets. Some examples of force applications are strategic attack, air interdiction, and close air support. The Air Force generally

conducts strategic attacks through aerial bombardments against enemy resources they need to sustain their combat operations [Ref. 16: p. 6]. These resources may included seaports, airports, and sea lines of communications [Ref. 8: p. I-4-8]. The goal of air interdiction is to destroy, disrupt, or degrade the enemy's combat potential, by attacking enemy movements, supply routes, and ammunition holding areas. Ground units may receive close air support to enhance their efforts to concentrate their total combat power needed to achieve their tactical objectives. [Ref. 16: p. 11]

Force enhancements are missions that improve the combat effectiveness of both surface and Air Forces. Examples of force enhancements may include the following:

- Airlifting personnel and equipment into the combat zone
- Conducting in-flight refueling operations to increase range, payload, and duration of air assets
- Spacelifting critical navigation, communications, and intelligence satellites
- Performing aerial reconnaissance and surveillance operations
- Electronic warfare operations to maintain friendly use of the electromagnetic spectrum while denying its use to our adversaries
- Providing airborne command and control centers.

Force support are missions associated with sustaining military operations within the theater such as establishing and defending forward air bases, providing logistics support, and controlling space-based platforms. These missions not only support the Air Force, but the other services as well. [Ref. 16: p. 6]

Most Air Force units perform more than one of the missions described above. Additionally, the Air Force has special operations forces who receive highly specialized training and use customized aircraft to perform a variety of missions introduced throughout the conflict spectrum. These forces are normally employed as a member of a Joint Special Operations Task Force (JSOTF). [Ref. 8: p. I-4-14]

C. COLLATERAL MISSIONS

Besides the Air Force's primary roles and missions, it has several collateral responsibilities to support Marine and Naval forces. Some examples of these missions include sea surveillance, aerial minelaying operations, and defense of SLOCs. The Air Force's ability to accomplish these missions gives the joint commander extreme flexibility to accomplish his/her operational objectives. [Ref. 8: p. I-4-8]

D. ROLES IN SUPPORT OF NATIONAL STRATEGY

The Air Force plays a vital role in supporting the national strategy of the NCA, by establishing global presence. The Air Force publication, *Global Presence 1995*, presents three tenets that expand the traditional meaning of presence to reflect modern views on projecting military forces. The three tenets for establishing a global presence include: [Ref. 17]

- All military forces can exert presence through the right combination of their capabilities
- Forces have unique attributes that exert presence when applied so they complement each other in an area of operation

- Advancing technology enhances the contributions of military forces in performing presence missions by improving their situational awareness, strategic mobility, and force lethality

The Air Force publication, *Global Power-Global Reach*, outlines five specific principles for using air and space power to project military power and support national strategy. These principles are sustain deterrence, provide versatile combat capability, supply rapid global mobility, control the high ground, and build U.S. influence. [Ref. 18: pp. 3-4]

Aerospace forces have the capability to deliver nuclear munitions anywhere on the globe. This capability acts as a deterrent to potential adversaries who must first consider the adverse consequences of launching nuclear or biological strikes against U.S. Forces or one of its allies. Today's long-range bomber and fighter aircraft give the NCA the capability of projecting versatile air combat power when and where needed to gain air superiority in any theater of operations. This capability along with other forward deployed forces, allows the nation to respond to a variety of crises throughout the conflict spectrum. [Ref. 18: pp. 5-6]

The Air Force's airlift and air tankers, improve the global mobility of not only the aerospace forces, but Army and Marine ground forces as well. During Desert Storm/Shield, air tankers supported the successful bombardments of targets located deep into Iraq, by providing both U.S. and Coalition strike aircraft with in-flight refueling services. [Ref. 18: pp. 7-8]

Aerospace forces are charged with the primary responsibility to gain and maintain unprecedented control of the high ground. By accomplishing this role, the Air Force can provide the NCA and operational commanders with real-time information regarding battle damage assessment, disposition of enemy forces, location of ballistic missile launches, and navigation services. [Ref. 18: pp. 8-9]

The Air Force's capability to rapidly project global combat power and U.S. influence to distant regions, demonstrates the country's resolve to protect its national interests. This in turn, plays a vital part in strengthening U.S. relations with our allies. [Ref. 18: p. 9]

These five principles form the basic framework to aid decision makers on how and when to deploy aerospace forces to accomplish national and strategic objectives. Furthermore, they provide the pillars that support the Air Force's overall mission of defending the U.S., by exploiting the air and space medium. [Ref. 18: p. 3]

E. AIR FORCE ORGANIZATION

The organization of the Air Force consists of major commands, numbered air forces, wings, and squadrons to fulfill both its peacetime and wartime missions. This organization is shown in Figure 10. Similar to the chain of commands in other services, the NCA communicates their strategic and military objectives through the Chairman of the JCS to combatant commanders. The combatant commander relies on input from their service component commanders within each theater to develop their campaign plan that integrates all available air assets. Air Force component commanders, such as the Commander of Central Air Forces (CINCUSAFCENT) and the Commander of Europe Air Forces (CINCUSAFE), provide operational guidance to the major Air Force command under their authority [Ref. 4: pp. 2-3, 2-28 to 2-29]. Major Air Force commands may consists of two or more numbered air forces. Numbered air forces are composed of either multiple-objective or composite wings. Multiple-objective wings normally contain similar aircraft such as bombers, fighters or airlift aircraft. The combination of two or more of these wings are referred to as multiple-wings. Composite wings are organizations consisting of a combination of different types

of aircraft within each wing. Both multiple-wings and composite wings are functionally organized within the theater to facilitate support and maintenance requirements. Regardless of the type of wing, each is composed of one or more

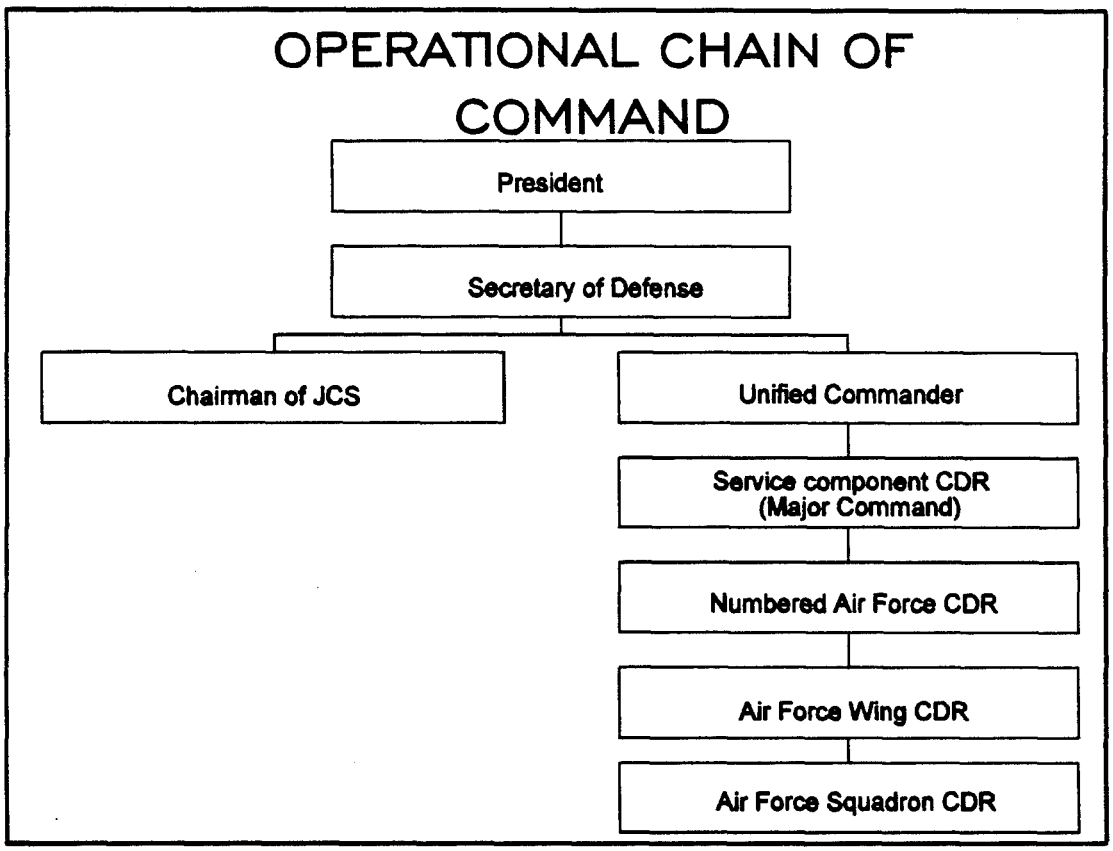

Figure 10. Air Force Operational Chain of Command. [Ref. 8: p. I-4-3]

groups or squadrons made up of approximately 28 aircraft and a full maintenance crew of about 2,000 to 4,000 personnel. [Ref. 8: pp. I-4-2 - I-4-3]

During joint operations, the Air Force's air component commander is often designated as the Joint Forces Air Component Commander (JFACC). The JTF commander normally designates the JFACC from one of the services participating

in the operation. The primary factor that drives this decision is which the service has the preponderance of aircraft operating in the area.

Air component commanders and the JFACC use the Air Tasking Order (ATO) to document their operational objectives to their subordinate air commanders. The use of ATOs support the concept of centralized control and decentralized execution for using and employing air assets. Upon receipt of the ATO, subordinate commanders exercise a decentralized concept to develop and execute their own concept of operations to meet stated objectives. [Ref. 8: p. I-4-4]

A notional tactical communications architecture in a joint environment is shown in Figure 11. The joint air service component commander operates from an Air Operations Center (AOC) where he generates ATOs to his subordinate commanders. The AOC communicates directly with Forward Air Controller Posts (FACPs), Airborne Forward Air Controller (AFAC), Airborne Battlefield C2 Center (ABCCC), Wing Operations Centers (WOCs), Air Support Operations Center (ASOC), and the other service component headquarters (army, navy, marines). The role of each of these operations centers are described below: [Ref. 14: p. 15]

- FACP - manages the tactical air space by controlling deployed aircraft and air surveillance operations
- AFAC - manages close air support operations, controls attacks, and performs battle damage assessments
- ABCCC - provides an airborne platform consisting of extensive communications facilities and display consoles to perform wide air space management, beyond the capabilities of the FACP

- WOC - receives ATOs from the AOC, performs detailed mission planning, issues execution orders to subordinate commander, and reports the ongoing status of the mission back to the AOC

- ASOC - collocates with army tactical operation centers to assist them managing tactical air space, controlling Tactical Air Control Parties (TACP), and coordinating aerospace assets to support ground operations.

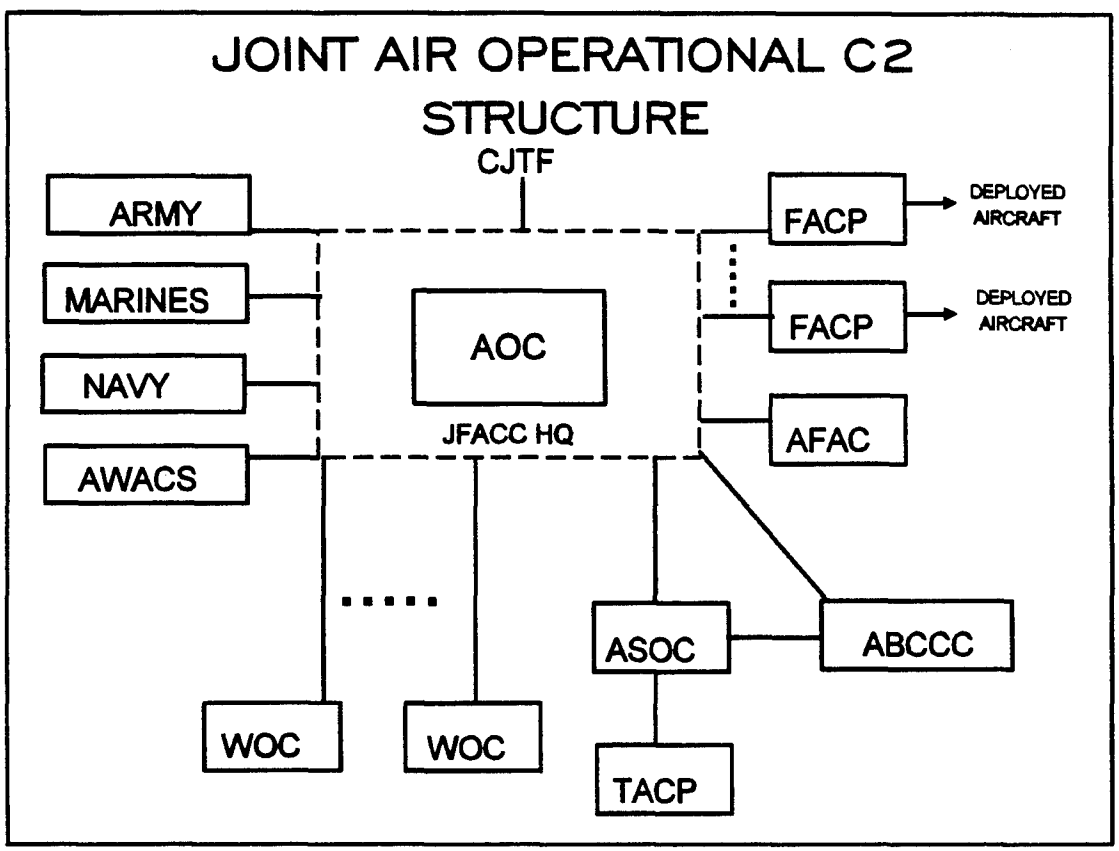

Figure 11. Joint Air Operations C2 Structure. [After Ref. 19: p. 15]

The tactical C2 architecture is designed to also support a centralized control and decentralized execution concept. In a joint environment, the Air Force component often takes the lead in air space management. It accomplishes this

through their dispersed operations centers from which they constantly coordinate with other services to maintain an overall unity of effort. [Ref. 8: p. I-4-4]

F. CAPABILITIES

The primary attributes of the Air Force are its speed, range, flexibility, and lethality. It possess the capability to project combat power anywhere in the world, often within 24 hours of notification. Through the support of in-flight refueling, the range of deployed aircraft can be extended great distances from their supporting bases. Flexibility is achieved by tailoring Air Force packages necessary to meet specific operational and strategic objectives. These forces may include an assortment of long range bombers (B-52s, B-1s), fighter aircraft (F-15s, F-16s, F-111's), reconnaissance aircraft (SR-71s, UR-2s, E-3s), and Close Air Support (CAS) aircraft (F-4s, A-10s). [Ref. 8: pp. I-4-6, I-4-20] As demonstrated in Desert Shield/Storm in 1991, many of these aircraft have state-of-the-art weapons systems that give them the capability to deliver ordinance with tremendous precision and lethality while simultaneously limiting collateral damage. The primary attributes offered by the Air Forces, provide operational commanders the ability to influence their 3-D battlespace so as to achieve their tactical, operational, or strategic missions.

G. LIMITATIONS

In contrast to the Air Force's many attributes, it has several inherent limitations such as large and costly support requirements. To sustain combat operations for any length of time, deployed aircraft require a large amount of logistical support and sizeable maintenance facilities. Examples of logistical support include ordinance, fuel, spare parts, and support personnel. Transporting this support forward to operational areas, often requires dedicating a significant

number of airlift assets for this purpose. Additionally, there are other considerations regarding forward positioning of support such as overflight rights to airspace, availability of locations having adequate runways, aircraft parking areas, and large maintenance hangers. Equipping aircraft with "smart" or precision munitions is expensive, since many of these rockets and missiles cost nearly a million dollars each. Although the Air Force has much to offer the operational commander, he must to consider the amount of resources required to sustain their capability. [Ref. 8: pp. I-4-17 to I-4-18]

H. WARFIGHTING PHILOSOPHY

There are three types of threats that commonly challenge the aerospace forces: surface, air, electronic threats. Two examples of surface threats are surface-to-air missiles and anti-air gunfire. Air threats include those that are created by hostile airborne platforms such as air-to-air missiles and aircraft cannons. Electronic warfare, initiated from surface, air, or space, are hostile attempts to track and identify friendly aircraft or degrade and destroy friendly C4I systems. The Air Force may attack all these threats individually or in conjunction with ground forces. Another, more common approach is to attack all threats simultaneously with combined air assets from all the services. Regardless of the method an operational commanders chooses, neutralization of these threats is a prerequisite for gaining air superiority. [Ref. 8: p. I-4-6]

The Air Force's warfighting philosophy and doctrine are based on seven tenants of aerospace power that include: centralized control/decentralized execution, flexibility/versatility, priority, synergy, balance, concentration, and persistence. Each of the tenants are described in the following paragraphs.

1. Centralized Control/Decentralized Execution

Centralized control of all air assets is essential to proper establishment of priorities, synchronization of combat power, and achievement of a common objective. For example, in a joint environment, air assets from all the services should be centrally controlled by one service component to maximize the total effectiveness of available air combat power. Much like the other services' warfighting philosophies, the execution phase of an operation should be decentralized and pushed down to the lowest possible command level. [Ref. 16: pp. 7-8]

2. Flexibility/Versatility

The range, speed, precision, and lethality of modern aircraft provide operational commanders with extraordinary flexibility and versatility to strike any enemy target, regardless of its location. This capability, combined with a properly tailored Air Force package, allows combat power to be applied at the right time and place, causing the most damage to enemy forces. [Ref. 16: pp. 7-8]

3. Priority

The commitment of aerospace forces necessitates prioritization of military goals and objectives. This is paramount to the successful integration of air combat power into the overall scheme of maneuver during battles, campaigns, or wars. To facilitate this process in a joint environment, joint and air component commanders must maintain a constant and open dialog. [Ref. 16: pp. 7-8]

4. Synergy

The use of aerospace forces in conjunction with surface gunfire and air assets that are organic to ground maneuver forces will produce a higher combat

effectiveness than the sum of their individual contributions. In other words, both air and ground forces must concentrate their efforts toward a common military objective, in order to obtain the optimum combat power available to the whole force. [Ref. 16: pp. 7-8]

5. Balance

As described earlier, surface, air, and electronic threats impose special considerations when using air assets. Since aircraft and highly trained pilots are not easily replaced, operational commanders must carefully access the risk involved in deploying air assets into high threat areas. To achieve their assigned objectives, commanders must deploy the right type or mix (balance) of aircraft and ground forces against any threat. [Ref. 16: pp. 7-8]

6. Concentration

Concentration is analogous to the concept of synergy. To harness the full combat power of aerospace forces, they should be employed in mass and focussed towards a specific military objective. Again, this combat power exceeds the sum of their dispersed or individual contributions to the operation. This further implies that commanders should avoid fragmented employment of aerospace assets to accomplish multiple missions, because it exposes these forces unnecessarily to higher risks. [Ref. 16: pp. 7-8]

7. Persistence

Once aerospace forces achieve air superiority, they should continually and relentlessly strike enemy targets to fully exploit the air and space medium. This may include constant bombardment of the enemy's C2 facilities, logistics supply lines, and potential avenues of approach. In Desert Shield/Storm, the constant

application of air power not only destroyed Sadaam Hussain's ability to maintain control of his forces, but produced overwhelming psychological degradation of his troops will to fight. This ultimately allowed U.S. and Coalition ground forces to achieve their military objectives in a matter of a few days. [Ref. 16: pp. 7-8]

The tenets of aerospace power, along with the standard nine principles of war, form the foundation of aerospace doctrine and warfighting philosophy. These seven tenets provide guidance to operational commanders when planning the employment and use of aerospace forces to achieve their military objectives. More importantly, they introduce additional considerations when achieving air superiority that are unique to the exploitation of the air and space medium. [Ref. 16: p. 8]

I. SUMMARY

The Air Force is charged with four primary missions that include aerospace control, force application, force enhancement, and force support. In order to accomplish these missions, the Air Force must rapidly gain and maintain friendly use of the aerospace environment while denying its use to hostile forces. During World War II, this idea prompted Field Marshall Montgomery to make the following statement:

> "If we lose the war in the air, we lose the war and lose it quickly" [Ref. 16: p. 9]

The primary mission of the Air Force is to defend the U.S. through the dominance of the aerospace medium. As a member of the joint military force, the Air Force must perform other collateral missions to support Marine and Naval forces such as sea surveillance, minelaying operations, and special operations.

The NCA and senior military leaders base their decisions as to how and when to commit aerospace forces on five fundamental principles. These principles

include; sustain deterrence, provide versatile combat capability, supply rapid global mobility, control the high ground, and build U.S. influence.

Today's Air Force is composed of highly sophisticated, technically advanced aircraft and weapon systems that give the force unique capabilities such as speed, range, flexibility, and lethality. Operational commanders integrate these capabilities, with those offered by the other services, in their military plans to acquire and maintain total control of the three dimensional battlespace.

The tailored organization of the Air Force is designed to facilitate centralized control and decentralized execution as they contend with three common types of threats: surface, air, and electronic. The seven tenets of the Air Force's warfighting philosophy provide commanders guidelines on how they will neutralize these threats to gain air superiority. Total dominance of the aerospace medium remains a prerequisite for the U.S. military and its Allies to achieve their political, national, and military objectives.

VI. U.S. ARMY ORGANIZATION AND WARFIGHTING PHILOSOPHY

A. INTRODUCTION

In the past, the Army has played an active role in preserving and protecting the nation's interests at home and abroad. The Army, along with the other services, have routinely supplied the country with combat-ready forces during numerous peace and wartime contingencies. Throughout history, constantly changing threats have caused the Army to routinely modify its force structure, in order to, achieve their strategic, operational, and tactical objectives. Today's Army continues to tailor its force to capture the advantages of advancing technology, support the increasing reliance on joint operations, and improve its overall combat effectiveness. The Army's ongoing modernization efforts have lead to the improvements of their doctrine, training, and quality of soldiers. Collectively these efforts have produced an Army unmatched by any potential threats arising out of the new world order.

The goal of this chapter is to describe the Army's organization, capabilities, limitations, and warfighting philosophy. This will establish a basic operational framework for understanding the Army's specific C2 functions and their supporting C4I systems. These will be later addressed in Chapter X.

B. PRIMARY ROLES AND MISSIONS

The U.S. Army's overall mission is to provide the NCA with a land-based military force capable of imposing national strategy, policies, and directives, by gaining and maintaining land superiority. This is achieved through the conduct of a full range of military operations ranging from missions other than war to participation in large scale ground campaigns. The U.S. Army operates as a

member of the joint team to protect the nation's interest both in the Continental United States (CONUS) and overseas. Like the other military services, the Army must be used in conjunction with other measures such as political, economical, and diplomatic actions to achieve objectives directed by the NCA. To fulfill all of its assigned responsibilities outlined in DoD Directive 5100.1, the Army must perform a number of primary and collateral functions.

The primary roles of the Army involve organizing, training, equipping, and deploying land forces required to prosecute its assigned missions throughout the conflict spectrum. Some of the functions associated with executing of these roles and protecting the country's military forces, facilities, and homeland, include the following: [Ref. 5: pp. 13-14]

- Conduct decisive and prompt combat operations to seize, occupy, and defend areas of interest
- Install and maintain combat service support to sustain land-based operations for the Army and other military services
- Perform air defense operations using organic assets
- Participate as a member of the joint force to support other joint military operations with the Army's assets and capabilities
- Act as the lead component for conducting Marine Corps and Army airborne operations
- Coordinate with other services to integrate space control operations into the Army's concept of operations
- Employ electronic warfare assets to maintain dominance of the electromagnetic spectrum
- Initiate psychological operations when required

- Install temporary military governments following the occupation of territories abroad
- Install, operate, and maintain land-based communications and network interfaces as required
- Perform and support special operations in land areas of interest

The key drivers that determine whether the Army will perform some, if not all, of the functions listed above include the level of conflict, magnitude of the threat, and force composition. For example, in support of other than war missions, it would not be uncommon for the Army to perform only a few of the functions such as psychological operations and the use of the Army's special operations forces. Conversely, in a larger conflict such as the Persian Gulf, the Army will perform all of the listed functions in some capacity. Ultimately, the number of functional roles performed depends on the level of conflict, the Army's participation, and the composition of joint forces.

C. COLLATERAL MISSIONS

As a member of the joint team, the Army is charged by the DoD Directive 5100.1 to perform several collateral missions to support the other services. Some of these missions include organizing, training, and equipping land forces to interdict and support maritime operations. To meet these mission requirements, the Army uses its organic assets to conduct supporting air defense, airborne, airmobile, and close air support operations. [Ref. 5: pp. 14-15]

D. ARMY ORGANIZATIONS

Within the Army, there are many different levels of commands or echelons. These levels are based on force size, force type, and nature of the conflict. The

later refers to missions or objectives assigned to organizations relative to either tactical or operational levels of war. [Ref. 8: p. I-3-5]

1. Tactical Level

At the tactical level of war, Army organizations are assigned specific tactical missions that normally contribute to higher level operational objectives for a specific theater of operations. Localized battles and engagements are two examples of tactical objectives. The type of organizations used to support the tactical level of war include company/battery/troop, battalion/squadron, brigade/group, divisions, and corps. [Ref. 8: p. I-3-6]

a. Company/Batteries/Troops

Company size organizations are composed of two or more platoons and a headquarters section. The platoons, usually configured alike, receive limited administrative and logistical support from the company's headquarters section. Infantry and armor companies often fight as a cohesive unit. In other units, however, such as attack helicopters and cavalry units, platoons may operate independently. These units are called troops as opposed to companies. Similarly, company size units in field artillery units are referred to as batteries. They generally operate as a cohesive unit to provide fire support for other maneuver units such as armor, cavalry, and infantry. [Ref. 8: p. I-3-6]

b. Battalion/Squadron

Battalion size units are composed of two or more companies and a headquarters company. Most Army battalions have three to five alike (line) companies that receive administrative and logistical support from a headquarters

company. Combat battalions such as armor and infantry, typically operate as a cohesive unit in an assigned area of responsibility on the battlefield.

A battalion size cavalry unit is called a squadron. Its composition differs from other combat units because it consists of both ground and attack helicopter companies/troops. It is capable of performing reconnaissance and security missions for a much larger organization. [Ref. 8: p. I-3-6]

c. Brigade/Regiments/Group

Brigade size organizations consist of two or more battalions and a separate headquarters company. These units can be categorized as maneuver or separate brigades. Maneuver brigades form the major combat elements within a division, however occasionally they may operate independently. Although not part of their organization, maneuver brigades often receive fire support, combat support, and combat service support through habitual relationships with smaller organizations. Examples of these organizations are aviation, field artillery, signal, chemical, and maintenance support units. Separate brigades usually reinforce corps or divisions with infantry, armor, engineer, and aviation. Separate brigade sized armored cavalry units are called regiments and brigade size field artillery units are called groups. Both the armored cavalry regiments and field artillery groups may also provide fire support and combat reinforcements to corps or divisions when operationally attached. [Ref. 8: p. I-3-6]

d. Divisions

The division is the largest Army organization that ordinarily trains, and fights as a combined arms team. Although the composition of a division will vary depending its type, all divisions consist of combat, combat support, and combat service support units. By design, divisions are self-sustaining and capable

of operating independently for long periods of time. They normally form the major maneuver elements within a corps. Common types of divisions in the Army are infantry, armor, mechanized infantry, airborne, and air assault divisions. [Ref. 20: p. 15]

e. Corps

The corps forms the Army's largest tactical unit. It consists of two to five divisions and a full compliment of other combat, combat support, and combat service support units. Corps are normally tailored to achieve specific missions for their designated areas of operation and can sustain operations longer than a division. Due to the size and flexibility, corps may operate as part of a larger land force (field army, army group, or theater army), a component of a joint force, or independently. [Ref. 20: p. 3]

2. Operational Level

Operational level missions or objectives assigned to Army organizations usually contribute to accomplishment of higher national and strategic objectives. This generally requires the conduct of large-scale land campaigns in a mature theater of operations. Two examples of these campaigns are Desert Shield/Desert Storm and World War II. The Army organizations used at the operational level are field armies, army groups, and theater armies. [Ref. 8: p. I-3-7]

a. Field Armies

A field army is an ad hoc organization formed by the theater army commander and typically consists of two or more corps. In a joint or combined operation, field armies may include units from other services or nations that

participate in major land campaigns. Operational missions assigned to field armies often contribute to the achievement of strategic objectives. If the field army is the largest land component in a theater, the field army commander may direct and orchestrate the entire land campaign. When a field army is part of an army group, it will form the group's major maneuver elements. [Ref. 8: p. I-3-7]

b. Army Groups

An army group, like field armies, is an ad hoc organization formed by two to five field armies. They would normally be used in a mature theater of operations against a well-organized and well-armed adversary. The commander of an army group may be designated as the land component commander for the theater. Fortunately, army groups have not been required since World War II. [Ref. 8: p. I-3-7]

c. Theater Army

The theater army serves as the service component in a theater of operations. It provides either or both operational and service support for all Army units in the region. As shown in Figure 12, the theater army commander is normally the Army Service Component in a unified command. He recommends to the theater CINC how to best employ and allocate Army forces. Additionally, the theater army commander is responsible for organizing, training, equipping, and maintaining the force as necessary for it to achieve its assigned objectives. [Ref. 8: p. I-3-8]

3. New Force Structure

The Army's force organizational structure is currently undergoing major revisions that will tailor the force to meet future contingency requirements

ARMY C2 STRUCTURE

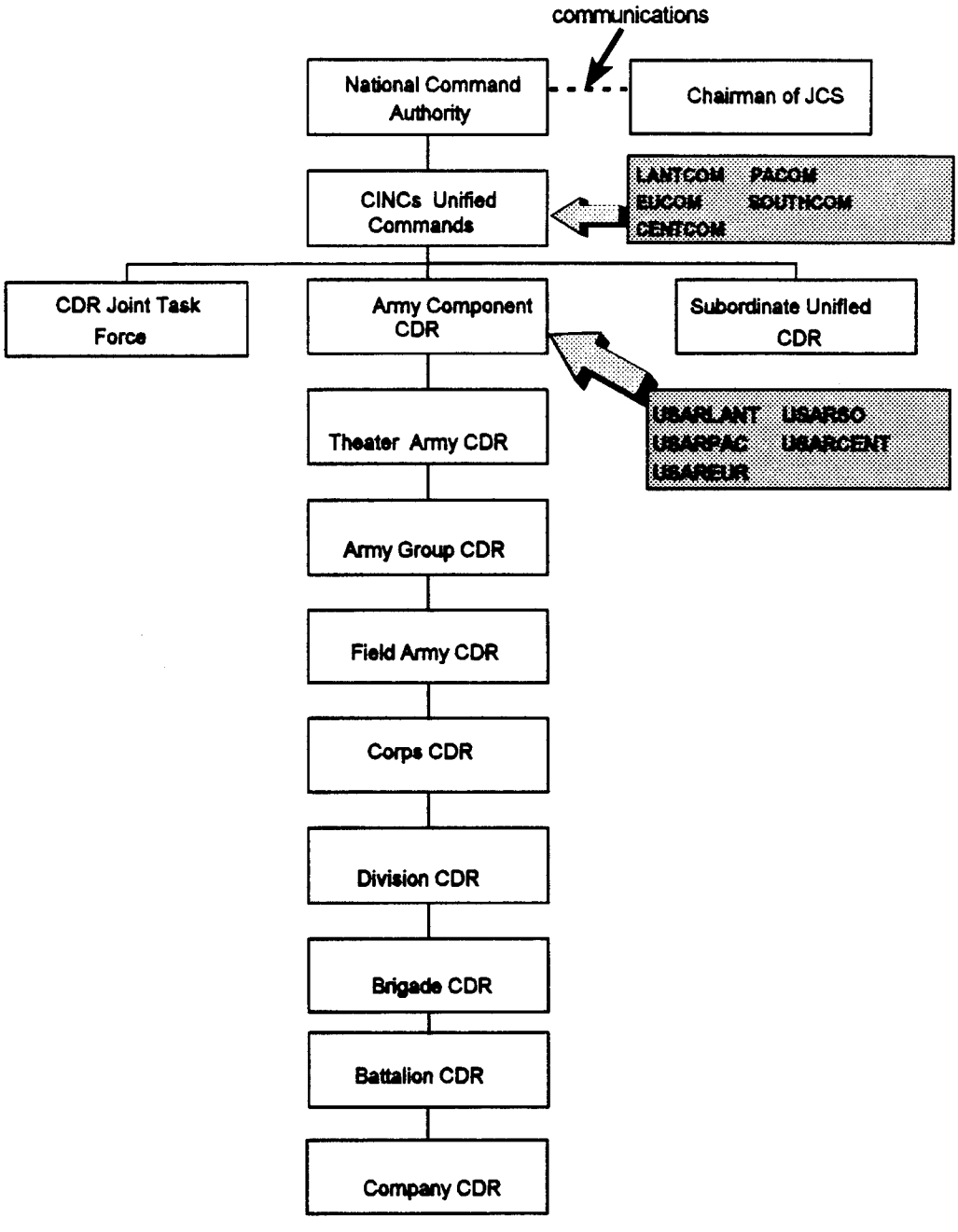

Figure 12. Army Operational Chain of Command.

during the post Cold War era. The new force structure will have the capability to respond to two major regional conflicts simultaneously. Following DoD's 1993 Bottom-up Review, a new concept plan evolved called the Force XXI Campaign Plan. This approved plan establishes guidelines for the Army's restructuring initiatives. The Force XXI Campaign Plan will reduce the current Army force to 10 active divisions, four corps, and three armored cavalry regiments by the end of FY 1996. Additionally, the plan will reduce the eight of National Guard divisions to five divisions and 37 brigades. Out of the 37 brigades, 15 will be designated as "enhanced" or readiness brigades. These units will be resourced so they can mobilize, train, and rapidly deploy to regional conflicts. [Ref. 21: p. 48]

The 10 active divisions remaining in the Army active force will include six heavy divisions, one airborne division, one air assault division, and two light divisions. All of these divisions, except two heavy divisions and one light division, will be based in CONUS. The other two heavy divisions will be stationed in Germany and the light division will be stationed in Korea. The four remaining corps will include: I Corps (Ft. Lewis, Washington), III Corps (Ft. Hood, Texas), V Corps (Germany), and XVIII Airborne Corps (Ft. Bragg, North Carolina). The three armored cavalry regiments remaining in the active Army force will include: 2nd Armored Cavalry Regiment (light), 3rd Armor Cavalry Regiment (heavy), and 11th Armored Cavalry Regiment (heavy). [Ref. 22: p. 46]

Under the new Force XXI Campaign Plan, each of the 10 active divisions will have three active brigades within their organizations. This differs from the "old way of doing business" where the division typically had two active brigades and one reserve component round-out brigade. National Guard readiness brigades that remain in the total Army force will no longer be part of the divisions, but instead be trained and equipped to deploy and operate independently of active forces. [Ref. 22: p. 46]

One of the Army's key emphasis areas as it reshapes its force is strategic power projection. The Army's goals are to develop the capability to project its military power using primarily CONUS based forces in an effort to minimize the permanently deployed force overseas. By implementing this concept, the Army will continue to increase its reliance on airlift and sealift assets, normally provided by the other services. As the Army attempts to restructure and relocate the preponderance of its force to CONUS based installations, several issues of C2 have surfaced regarding the geographical separation of some brigades from their parent divisions. To resolve these issues, the U.S. Army Forces Command (FORSCOM) will provide day-to-day administrative and resource support for these brigades, however, the parent division must maintain operational C2 over the displaced units. [Ref. 22: p. 47]

E. CATEGORIES AND CAPABILITIES OF ARMY FORCES

Army forces can be grouped into five broad categories. These categories are heavy forces, light forces, fire support, aviation, and special operating forces. Each category represents forces having similar firepower, lethality, equipment, and limitations, however, differ in their functional roles and missions. The following paragraphs describe the type of forces that compose each category and their contributions to the Army's AirLand Battle concept. This concept will be discussed later in this chapter.

1. Heavy Forces

Heavy Forces give the Army the capability to defeat a well-equipped and well-organized adversary. Three types of heavy forces in the Army are armor, mechanized infantry, and armored cavalry regiments. The common weapons system used by these forces include Abrams tanks, Apache attack helicopters,

Bradley fighting vehicle, and Multiple Launch Rocket Systems (MLRS). [Ref. 8: p. I-3-8]

Armor units employ the Abrams tank as the primary weapon to conduct mounted warfare. This style of warfare takes advantage of the tank's speed, armor, and firepower to breakthrough heavily defended areas, strike deep into enemy territories, and pursuit withdrawing enemy forces. Armor units are best suited for fighting in open terrain, like the desert, that allows tanks to be used at their maximum effective ranges. Conversely, heavy vegetated terrain, cities, and soft or wet areas will restrict the mobility and reduce the combat effectiveness of these forces. [Ref. 8: p. I-3-8]

Armored cavalry units are specialized and uniquely organized armor units designed to perform reconnaissance and security missions. Normally augmented with attack helicopters and tanks, armored cavalry units perform key tasks such as finding the enemy, establishing initial contact, and developing the tactical situation.

Mechanized infantry forces use their Bradley fighting vehicles to perform either mounted or dismounted operations. When mounted, infantry soldiers rely on their armor plated fighting vehicles to provide limited firepower and protection, as they maneuver rapidly across the battlefield. The major contribution of mechanized infantry forces is their capability to dismount from their vehicles, upon reaching areas that would otherwise limit the mobility of armor forces. Although the increased mobility and versatility of mechanized infantry forces can compensate for limitations imposed on armor units, their fighting vehicles lack the firepower of the Abrams tanks. [Ref. 8: p. I-3-9]

2. Light Forces

The Army relies on light forces to rapidly respond to global regions so they can accomplish strategic, operational, or tactical objectives. Since these highly versatile forces use only light armored vehicles, they are not hindered by transport limitations inherent to deploying heavy forces. There are two types of light forces in the Army: light infantry and motorized infantry. [Ref. 8: p. I-3-9]

Light infantry typically serves as a initial entry force into a theater to secure key areas and facilities that will support follow-on deployments of heavy forces. Capable of operating in any terrain or weather, light forces are particularly suited for missions associated with low intensity conflicts. The Army may also use its light forces to penetrate areas not suitable for heavy forces such as wetlands, urban areas, densely vegetated terrain. Other missions applicable to light forces include assaults on rear area facilities, exploiting the success of heavy forces, and leading a combined arms attack. [Ref. 8: p. I-3-9]

Motorized infantry serve as a rapid deployable light armored force to meet and destroy an enemy's heavy threat. Even though the motorized infantry offers greater firepower, lethality, and protection than light forces, it still lacks the full combat capabilities of conventional heavy armor or mechanized infantry units. Missions commonly assigned to motorized infantry units include the following: [Ref. 8: p. I-3-9]

- Attack against enemy forces in the open
- Envelop and infiltrate lightly defended areas
- Exploit the successful penetration achieved by heavy friendly forces
- Protect friendly rear area operations and facilities
- Pursue and exploit retreating enemy forces
- Dismount and fight as light infantry

3. Army Aviation

The three types of aviation units in the Army are attack helicopter, air cavalry, and combat support aviation units. These units are active players in combined arms operations, due to the operating characteristics of today's modern rotary-wing aircraft. Some of these characteristics are speed of movement, freedom of terrain, and insensitivity to weather conditions. [Ref. 8: p. I-3-10] Aviation units employ their attack helicopters, like the AH-64 Apache helicopter and the AH-1 Cobra helicopter, to provide ground commanders with additional capabilities to concentrate their firepower at the right time and place on the battlefield. Attack helicopters are equipped with advanced weapon systems that are particularly suited for attacking large enemy armored formations. Air Cavalry units use their attack helicopters, during screening and reconnaissance missions, for close air support and to protect ground elements in a division cavalry squadrons or armored cavalry regiments. Combat support aviation units use support aircraft such as UH-1 Hueys, UH-60 Blackhawks, and CH-47 Chinooks, to perform a wide range of missions to support ground operations. These operations may typically include troop movement/insertion, transport of critical logistics, and providing airmobile C2 platforms.

4. Fire Support

Field artillery units are the principle elements used to provide fire support to maneuver ground forces. The integration of fire support into the commander's scheme of maneuver requires the proper employment, coordination, and control of weapon systems organic to field artillery units. This is accomplished by establishing fire control measures such as No Fire Areas (NFA), Restricted Fire Lines (RFL), Fire Support Coordination Lines (FSCL), and Coordination Fire Lines (CFL) as shown in Figure 13. Army field artillery units support maneuver

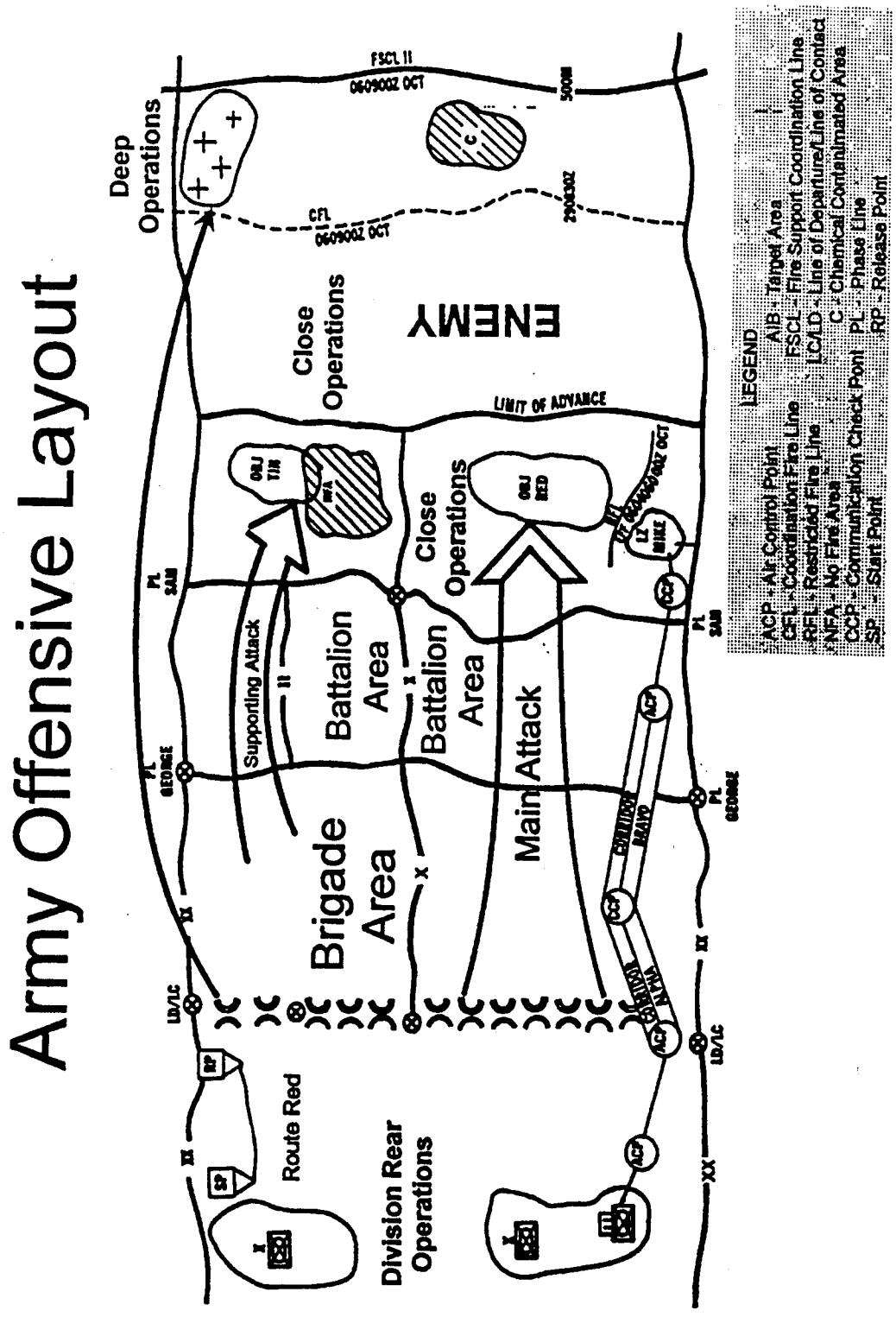

Figure 13. Army Offensive Layout.

forces by using their mobile weapons systems to deliver conventional, nuclear, chemical, rockets, and missiles. Mission assigned to field artillery units typically include:

- Suppressing enemy direct and indirect fire support capabilities
- Delivering scatterable mines to impede the mobility of enemy forces or to protect friendly forces
- Destroy targets deep within enemy territory

5. Special Operating Forces

Special Operating Forces support tactical commanders with a broad range of military options. Special forces, rangers, special operations aircraft, psychological, and civil affairs units, are common types of special operating forces found in today's Army.

Special forces are composed of elite forces with highly specialized skills. The primary mission of the special forces is to promote regional security and stability. They accomplish their mission by performing many different roles such as foreign military assistance, conventional and unconventional warfare, strategic reconnaissance, counterterrorism, and humanitarian assistance. Special forces groups, operating as subordinate organizations under the Special Operations Command, generally provide direct control over special forces units. [Ref. 8: p. I-3-11]

Rangers are rapidly deployable light infantry forces that conduct special operations to accomplish key military objectives. Their unique capabilities augment the forcible-entry capabilities of the Army, as it deploys into hostile regions. [Ref. 8: p. I-3-11]

The Army Special Operations Aviation's (SOA) primary mission is to support the special operations forces by using specially modified aircraft that are capable of performing covert troop insertions and extractions. The SOA supports not only the Army, but special operations forces provided by the other services as well. [Ref. 8: p. I-3-11]

The U.S. Army psychological operations forces are often deployed into denied areas to create favorable perceptions of U.S. forces. If properly employed, these forces can shorten conflicts, reduce potential casualties (civilian and military), and achieve specified military objectives using only minimum force. The majority of the Army's psychological operation forces are provided by the Army's reserve component. [Ref. 8: p. I-3-12]

Civil Affairs units are normally employed to interface with civilian governments to promote trust and approval for the occupation of U.S. forces. Currently there exists only one civil affairs unit on active duty (Fort Bragg, North Carolina), with the remaining 36 civil affairs units being provided by the Army reserve. [Ref. 8: p. I-3-12]

F. LIMITATIONS

Although Army forces are capable of projecting a sizeable and lethal land force world-wide, they are plagued with several inherent limitations. These limitations include the lack of organic lift assets, reductions in forces, and geographical dispersions between some CONUS based brigades and their parent divisions.

The Army's modern strategy centers on the global projection of its CONUS based forces abroad to protect U.S. interests during international crises. This causes the Army to rely on the Air Force's air and the Navy's sealift assets for mobility to their areas of operations. In the event the situation calls for the use of

heavy forces such as required in Desert Shield/Desert Storm, the Army requires tremendous lift support to deploy their forces in a timely and responsive manner. The time required for heavy forces to mobilize to the theater rests solely on the availability and often limited resources of the other services. To overcome this limitation, the Army, with assistance from the Navy, is currently establishing forward positioned sites of heavy equipment that are afloat near potential crisis regions. These initiatives, along with other ongoing modernization programs to improve the airlift and sealift assets in the Air Force and Navy respectively, will lead to improvements in the Army's capability to deploy its heavy forces. [Ref. 23: p. 20]

The Force XXI Campaign Plan mandates the Army must reduce its force to 10 active divisions. This new force structure will be capable of conducting two major regional conflicts simultaneously. The Army's force size was determined based on two medium, as opposed to high, intensity conflicts. To overcome this limitation, the Army plans to rely on continued procurement of state-of-the-art weapons and C4I systems, a highly trained and synchronized force, and its effective use of National Guard and reserve components. [Ref. 23: p. 20]

In the past, Army divisions typically used routine and local field training exercises on their assigned installations to maintain a highly cohesive combat organization. With some of the brigades geographically separated from parent their divisions, this is no longer economical or in some cases feasible. To maintain the combat readiness and cohesiveness in the divisions, the Army must now develop innovative methods to overcome this limitation. This will demand the use of more extensive brigade level training exercises, modern computer training simulators, and well orchestrated division level training exercises, whenever possible. Despite its limitations, the Army will continue to direct its efforts toward

developing highly competent leaders, modernizing the force, and capitalizing on tough realistic training, as they prepare for future contingencies.

G. ARMY'S WARFIGHTING DOCTRINE

The Army's warfighting doctrine consists of two fundamental doctrines that exploit the advantages offered by a multi-dimensional battlefield. These two warfighting doctrines are AirLand Battle and AirLand Operations. There are five tenets of AirLand Battle that provide today's Army commanders with a doctrinal guide to conduct both offensive and defensive operations against an adversary. The five tenets, as well as, the purpose for conducting offensive and defensive operations will be described later in this section.

1. AirLand Battle Doctrine

The Army's primary warfighting doctrine is called AirLand Battle. It servers as the foundation from which the Army organizes, trains, equips, and employs its forces. The AirLand Battle doctrine was developed based on proven maneuver tactics and principles learned from the Army's past involvement in combat. This doctrine, introduced by FM 100-5 in 1986, applies to ground and air operations on a linear battlefield. A linear battlefield refers to the conduct of battle where the force's main objective has spatial orientation such as seizing, and holding key terrain or areas of interests. By taking advantage of the battlefield's full dimensions, AirLand Battle doctrine provides a framework for planning and executing land campaigns, major conflicts, battles, and engagements. [Ref. 8: p. I-3-12 and Ref. 12: p. 14]

Proper use of AirLand Battle doctrine requires Army, joint, and multi-national forces to integrate close, deep, and rear battle operations on a linear battlefield. Close operations pertain to the operations using forces directly in

contact with the enemy. Deep operations are the operations directed at enemy capabilities necessary to sustain, reinforce, and control their forces engaged in close combat operations. Examples of deep operations are disrupting or destroying an adversary's C2 centers, reserve forces, and logistics bases (including industrial bases) located in their heartland. Rear battle are operations to protect friendly actions and facilities necessary to sustain close and deep operations, as well as, posture the force for future operations. Friendly rear operations must be included in planning the disposition of forces since it is often vulnerable to deep attacks. [Ref. 8: p. I-3-12]

2. Tenets of AirLand Battle

The AirLand Battle doctrine is a maneuver oriented doctrine that commanders use for developing their creative, innovative, and flexible operational plans. These plans must capitalize on advantages offered by the coordinated application of air, land, and naval forces in a multi-dimensional battlespace. The five tenets that support the AirLand Battle doctrine are initiative, agility, depth, versatility, and synchronization. [Ref. 24: pp. 2-6 to 2-9]

a. Initiative

Initiative refers to the spirit or momentum of the battle produced through successful application of offensive tactics. Gaining and maintaining the initiative causes the enemy to become reactive to proactive actions imposed by friendly forces. Obtaining the initiative is a prerequisite for achieving favorable outcomes in combat. [Ref. 24: pp. 2-6 to 2-7]

b. Agility

Agility is the ability of friendly forces to quickly maneuver and concentrate their full combat power to exploit exposed enemy vulnerabilities. This requires commanders to rely on real-time intelligence sources and tactical decision aides that identify enemy vulnerabilities and intercept their tactical decision making cycle. Agility allows commanders to anticipate future enemy actions and responses, so they can adjust the movement of their forces accordingly to achieve a decisive advantage. [Ref. 24: p. 2-7]

c. Depth

Depth refers to the commanders' ability to employ their combat resources, such as organic aircraft and supporting special operating forces, to attack targets deep within enemy territory. These targets might include the enemy's C2 centers, logistics facilities, and reserve forces that would support the enemy's capability to sustain current or future combat operations. [Ref. 24: p. 2-7]

d. Versatility

Versatility is the ability to tailor the organization as needed to meet a wide range of contingency requirements created throughout the spectrum of conflicts. It allows the smooth transition from one mission to another to meet changing threats, operational environments, and assigned objectives. For example, an Army Engineer unit may quickly change its mission from installing obstacles on the battlefield to performing other that war missions such as restoring water and power facilities. Well-led, well-trained, and well-equipped forces are essential factors in developing versatility among Army forces. [Ref. 24: p. 2-9]

e. Synchronization

Synchronization is the arrangement of activities that bring to bear the full thrust of combat power at the right time and place. These activities are essential for the Army commander to produce desirable outcomes during a decisive engagement on a multi-dimensional battlefield. [Ref. 8: p. I-3-14] Commanders achieve synchronization by organizing the displacement of their forces and designating boundaries which delineate each unit's operational areas. Figure 13 shows an example of how a division typically displaces during an offensive operation conducted on a linear battlefield. The figure also shows examples of control measures commonly used by the commander to plan, execute, and control the movement of their forces during Army land operations. Examples of these control measures include phase lines, unit boundaries, axis of advance, and lines of departure/lines of contact. Whether shown on hardcopy overlays or computer displays, all control measures share the common goal of supporting the C2 over battle forces. Battle staffs achieve this goal by providing their commander with location, progress, and movement routes of friendly forces. [Ref. 24: pp. 2-8 to 2-9 and Ref. 25]

3. AirLand Operations

AirLand Operations doctrine is an extension of the AirLand Battle that applies to the conduct of combat operations on a nonlinear battlefield. A nonlinear battlefield differs from a linear battlefield, because on a nonlinear battlefield the main objectives are not relative to spatial orientation (seizing and holding key terrain), but instead geared toward destroying specific enemy capabilities. AirLand Operations provide the basic doctrine for employing long-range weapon systems to strike enemy capabilities they need to continually wage war. Examples of these capabilities include scud launchers, critical C2 nodes, and logistic

facilities. Another fundamental difference between the AirLand Battle and AirLand Operations doctrines is that in AirLand Operations, friendly forces generally avoid using high attrition style warfare tactics to destroy the enemy's will to fight. Advanced weapons, precision munitions, improved intelligence collection, and integration of joint forces must be incorporated into the concept of operations to achieve desirable outcomes on a nonlinear battlefield. [Ref. 8: pp. I-3-16 to I-3-17]

It is not uncommon for Army commanders to use both AirLand Operations and AirLand Battle doctrines in developing their operational plans. Both provide Army commanders with a vehicle to successfully plan and execute offensive and defensive operations as they participate in land warfare. The Persian Gulf War provides a classic example of how the both linear and nonlinear battle doctrines were applied by coalition forces to defeat Iraq's Republican Guard Force and destroy their will to fight.

4. Offensive Operations

The Army warfighting philosophy and doctrine hinges on the success of offensive operations. It is the only decisive form of war to defeat a heavily armed and well-organized opposing forces during medium to high intensity conflicts. Successful offensive operations demand tempo, surprise, concentration, and audacity. The Army's FM 100-5, *Operations,* describes the four sequential phases of an offensive operation as movement to contact, attack, exploitation, and pursuit. Although the primary objective of any offensive operation is to defeat the enemy's will to fight, other reasons for undertaking offensive operations may include the following: [Ref. 24: pp. 7-0 to 7-3]

- Securing decisive terrain
- Depriving the enemy resources
- Gaining information to deceive or divert the enemy
- Holding the enemy in place
- Establishing conditions favorable for future operations

The Army uses six forms of maneuver to conduct offensive operations including envelopment, infiltration, turning movement, penetration, and frontal attack. In offensive operations the acronym METT-T is commonly used by Army commander's to access the tactical situation and determine which form of offensive maneuver to use. This acronym represents the assigned mission, enemy actions, friendly troops available, terrain, and weather. A commander's selected form of maneuver is normally stated and relayed to subordinates as the commander's intent or concept of operations within an operation order. [Ref. 24: p. 8-1]

5. Defensive Operations

Defensive operations are normally conducted as part of major campaigns, battles, or engagements and often used in combination with offensive operations. The Army's purposes for conducting defensive operations are to halt or delay enemy attacks, exercise economy of force, retain ground, and gain time. Since a defensive operation is a less decisive form of war, it is normally used temporarily until friendly forces have the capability to transition to the offense. This is typically accomplished by conducting a counterattack at the point when enemy forces loose their offensive initiative (sometimes referred to as the culminating point). The two common types of defensive operations are mobile and area defense. During mobile defense operations, Army commanders allow an attacking

enemy force to advance into a position that exposes it to a counterattack or envelopment by a mobile reserve forces. Area defense operations are static in nature. During these operations, the Army establishes stationary defensive positions to secure its key terrain while using its reserve forces to halt enemy efforts attempting to penetrate between them. A situation where the Army would uses a defense operation is during its initial deployment into a theater of operation while they are being attacked by an aggressive force. During this phase of the operation, initial Army forces would conduct a defensive posture to wait for additional reinforcements. Eventually some form of offensive operation will be necessary for the Army to achieve its military objectives. [Ref. 8: pp. I-3-23 to I-3-24 and Ref. 24: p. 9-0]

H. SUMMARY

Modern Army organizations combine state-of-the-art weapon systems with the world's highest trained soldiers. This combination produces deployable land-based forces that are capable of protecting national interests around the world. The NCA uses the Army's military power, in conjunction with other options, such as economical, political, and diplomatic measures, to accomplish specific strategic, operational, and tactical objectives. Although the Army's primary mission is to organize, train, equip, and employ its land forces to wage war against hostile forces, it has several collateral missions as well. These collateral missions include integrating and employing the Army's land forces, their capabilities, and their organic assets to support joint and combined operations.

Versatility is a salient characteristic of today's Army Forces. It is created by the diverse units that compose its organizational structure both at the tactical and operational levels. Army's units at either level (tactical or operational) may consist of various types of unit that fall under five broad categories. These

categories are heavy, light, aviation, fire support, and special operations forces. Adding to the Army's versatility, is the capability of tailoring its forces to meet changing operational requirements imposed throughout the conflict spectrum.

The Army is continually updating and modifying its warfighting doctrine to keep pace with a changing national strategy. Its current doctrine is based on both the AirLand Battle and the AirLand Operations doctrines. Army commanders may use the AirLand Battle doctrine as a basic foundation for developing their concept of operations and exercising C2 over their forces fighting on a linear battlefield. In addition, commanders may elect to use the AirLand Operations doctrine, separately or in combination with the AirLand Battle, to employ and fight their forces on a nonlinear battlefield. Both doctrines favor offensive warfare as primary means for producing decisive outcomes during combat.

Modernization efforts continue to be one of the Army's highest priorities. The Force XXI Campaign Plan is the approved roadmap for modernizing the Army's organizational structure. This plan is based on the anticipated success of other ongoing Army and joint programs that will capture and integrate advancing technologies of new weapon and C4I systems into the force. These systems will in turn, provide tomorrow's Army commanders with the capability to fight effectively with smaller, more lethal forces.

VII. NAVY COMMUNICATIONS

The previous four chapters have outlined each of the services' organization, missions, roles, and warfighting philosophies. The goal of these chapters was to provide an operational overview in how each of the services deploy, function, and contribute to the DoD's overall functions presented in Chapter II. This knowledge will provide the framework for understanding how the each of the services apply their unique C4I systems and supporting communications systems to meet the C2 requirements of theater and tactical commanders.

This chapter, along with Chapters VIII through X will begin by introducing the each of the service's primary C4I systems. This will be followed by an explanation on how subcomponents of these systems or other service unique C4I systems support five common C2 functional areas. These five functional areas are intelligence, fire support, air operations (air defense), maneuver, and logistics. To provide a well-rounded discussion on the Navy's C4I systems, requires a presentation on the various types of C4I communication support systems they use in their unique operating environment.

A. NAVY'S PRIMARY C4I SYSTEMS

The primary C4I systems used in today's Navy is the Joint Maritime Command Information System (JMCIS). The need for JMCIS surfaced as the Navy attempted to upgrade many of their separate afloat and ashore C4I systems such as the Joint Operations Tactical System (JOTS) and its derivative systems. During this attempt, they found that many of these separate systems had duplication in both system functions and software components. This duplication drove up development, maintenance, and training costs. In addition, many earlier Navy systems were not only incompatible with other Navy command information

systems, but more importantly, different systems did not provide the user with consistant information. JMCIS, however, offered both a feasible and economical alternative to resolving these issues. [Ref. 26]

JMCIS was developed using a common software set called Unified Build. This software consolidated key features and software programs from earlier systems (prior to 1993), thereby eliminating duplication. The Unified Build is not a deliverable system to the end user, but rather a set of development tools, documentation, and modules for building a command information system. This allowed system developers to merge the operational functions of existing C4I systems. [Ref. 26: p. 1-15]

JMCIS is based on an open client-server architecture that consists of UNIX workstations connected to a Local Area Network (LAN). The workstations, normally located in command information centers (CICs) onboard ships or in shore based command centers, allow users to query a centralized database for specific information. [Ref. 26: pp. 2-5 and 2-14]

A key feature of JMCIS is that it uses a common operating environment which includes commercial off-the-shelf software (COTS) and core software utilities. Two examples of COTS software are the system's basic operating system and a windows environment. The core utilities used in JMCIS include receiving and processing messages, message correlation, updating the track database, and software for generating cartographic displays. COTS, core software utilities, and the client-server architecture allow the system to receive messages and track information, even when the operator is not logged into a workstation. Since JMCIS is developed using a common operating environment, it offers full interoperability with other JMCIS users in the Marine Corps and U.S. Coast Guard. In addition, its modular design will also facilitate future system upgrades and integration into the Global Command and Control System (GCCS) to support

its users changing C2 requirements. GCCS will be discussed in futher detail in Chapter XI. [Ref. 26: p. 2-3]

Two prominent Navy C4I systems that contributed functions to JMCIS are the Naval Tactical Command System-Afloat (NTCS-A) and the Operations Support System (OSS) or Naval Command and Control System-Ashore (NCCS-A). Their merger established a single, consolidated C4I system (JMCIS) that meets the needs of both communities. [Ref. 26: p. 1-1]

1. Navy Tactical Command System-Afloat (NTCS-A)

The NTCS-A was originally formed by consolidating several earlier generation information management systems used at sea to include: Joint Operations Tactical System (JOTS), for battle track management; Naval Intelligence Processing System (NIPS), for intelligence database management; Tactical Information Management System (TIMS), for status board displays; Navy Imagery Electronic Warfare System (NIEWS), for imagery acquisition; and assorted Tactical Decision Aides (TDAs), for supporting the tactical decision maker. This consolidation led to a set of common software called the Government off-the-shelf software (GOTS) version 1.1. The NTCS-A assisted both flag and unit level commanders (onboard Navy ships) in performing mission and data analysis requirements. This was accomplished by supplying them with a fused tactical picture of their battlespace, integrated intelligence processing services, and imagery exploitation capabilities. Additionally, the NTCS-A exchanged tactical information with other C4I systems such as the Combat Direction System (CDS) and the Tactical Air Planning System (TAMPS). [Ref. 26: p. 1-1]

2. Operations Support System (OSS)

The OSS, snyonomous with NTCS-A, was a command and control system used in Naval shore based intelligence and command centers. It was a composite of software functions that evolved from other C4I systems such as JOTS, the Navy's WWMCCS standard software, and the Fleet Command Battle Management Program. It served as the shore based version of the NTCS-A. The Navy merged the OSS with the NTCS-A to form a common software set called Unified Build version 2.0 or GOTS 2.0. This software incorporates key C2 functions that support both afloat and ashore operations. Furthermore, this software consolidation now forms the basic Unified Build software that will facilitate the integration of other C4I systems being developed by the U.S. Coast Guard and the Marine Corps. [Ref. 27: p. 24]

B. NAVY C2 FUNCTIONAL AREAS

There are five C2 functional areas that support naval commanders ability to maintain proper C2 over their forces. Each functional area maybe supported by one or more C4I systems that provide commanders with the information they need to assess the situation, make operational decisions, and disseminate guidance to subordinates. The five functional areas are intelligence, air operations, fire support, maneuver, and logistics. Described below are the system(s) the support each functional area. [Ref. 28: p.. 72]

1. Intelligence

The intelligence functional area is supported by the Naval Intelligence Processing System (NIPS). This is a subsystem of JMCIS that acts as a comprehensive military intelligence database server to assist flag and unit level commanders execute their assigned duties. NIPS consolidates, updates, and fuses

intelligence data collected from various sensors at the national, theater, and tactical levels. The system allows its users to query, display, update a wide variety of information from performance data for weapon systems and changes to the tactical situation. NIPS receives and disseminates information among its users by exchanging informaton over supporting communications systems like the Naval Automated Communication System (NAVMACS) and the Tactical Intelligence System (TACINTEL). NIPS' maintains several databases that contain collected, processed, and analyzed intelligence. Some of these databases are: [Ref. 29: p. 300]

- Integrated Database (IDB)
- Naval Intelligence Database (NID)
- Naval Emitter Reference File (NERF)
- Emitter Paramenter Listing (EPL)
- Message Database (MSGDB)
- Imagery Management Database (IMDB)
- Air Tasking Order Database (ATODB)

2. Air Operations

CVBG Air operations are supported by two primary systems: Tactical Air Mission Planning System (TAMPS) and Advanced Tactical EA-6B Mission Support System (ATEAMS). TAMPS facilitates mission planning and route analysis in support of power projection. It includes such capabilities as weapons loadout monitoring and radar prediction. ATEAMS supports air operations by providing users mission planning information for airborne electronic

countermeasures. In addition, it accepts postmission information for correlation and display on the user's workstation consoles. This system interfaces fully with TAMPS that retrieves the tactical picture and other related information from a centralized database in JMCIS. This capability provides complete support for the air operations C2 functional area. [Ref. 28: p. 89]

3. Fire Support

The C2 of naval fire support is performed by the Tomahawk Weapons Control System (TWCS) and the Combat Direction System (CDS). Both systems assist tactical commanders in assessing the situation, determining hostile targets, and designating/selecting weapon systems. [Ref. 28: p. 72]

TWCS provides the processing/control of targeting, engagement planning, and launch control for Tomahawk cruise missiles. This system also keeps a theater level ocean surveillance database and correlates contact reports from other systems, such as the Command and Decision (C&D) onboard Aegis Cruisers and other combat direction systems within JMCIS. Important to note is that TWCS provides a near real-time tactical picture of a large geographical area collected from offboard sensors. This capability allows the employment of ASUW missiles beyond the normal detection range of the ships onboard sensors. [Ref. 28: p. 57 and Ref. 30: p. 1-3]

CDS performs other fire support related functions such as: integrating ownership sensor data and tactical digital data link (TADIL) information; providing real-time situation monitoring; performing threat evaluations; and determining weapons assignments. It establishes a common database through information exchanges between the Combat Information Centers (CICs) onboard selected ships and other similar facilities used by air and ground forces. The connectivity for these communications links is provided by High Frequency (HF)

radios, Ultra High Frequecy (UHF) Line-of-Site (LOS) radios, satellite communications, all of which use JCS approved TADIL formatting. There are various configurations of CDS such as Aegis Command and Decision (onboard cruisers and destroyers), the Advanced Combat Direction System (ACDS, onboard carriers), and the older Navy Tactical Data System (NTDS, still onboard certain ships). The Navy will eventually replace the aging NTDS with the newer ACDS. [Ref. 6: p. 7-73 and Ref. 28: p. 78]

4. Maneuver

The maneuver C2 functional area is supported by two systems: CDS and the Joint Maritime Command Information System (JMCIS). As stated earlier, JMCIS is an evolutionary C4I system that incorporates key functions of the Naval Tactical Command System-Afloat (NTCS-A). These functions included tactical decision aides and intelligence management, to name only a few. Collectively all the functions in JMCIS (particularly those provided by NTCS-A) support the commanders afloat with a fused near-real time picture of their battlespace, so they can accurately assess the tactical situation. Similarly, the CDS affords commanders the ability to perform real-time situational monitoring, so they can make appropriate weapon assignments. Commanders may use information provided by both systems to determine where he should position his ships and weapon platforms to achieve a decisive advantage. [Ref. 28: p. 72]

5. Logistics

The logistics function is performed by the Naval Tactical Command Support System (NTCSS). This system was created from the merger of the logistical functions provided by many of the Navy's earlier stovepipe and legacy logistics information systems such as the Shipboard Nontactical ADP Program

(SNAP), the Maintenance Resource Management System (MRMS), and the Navy Aviation Logistics Command Management Information System (NALCOMIS). Currently the NTCSS is merging its functions into the JMCIS architecture. [Ref. 27: p. 28]

C. C4I COMMUNICATIONS SUPPORT SYSTEMS

In describing the various C4I communications support systems currently used by the Navy, this thesis categorizes them into either theater or tactical communications. Theater communications refer to systems that support ship-to-shore, ship to nonorganic activities, and connectivity to strategic networks like the Defense Communication System (DCS). Tactical communications refer to those systems which support ship-to-ship and ship-to-air communications. The primary characteristic used to categorize Navy C4I support systems into either theater or tactical communication system is the span of C2 provided by each system, relative to the theater of operations. As a reminder these systems are categorized subjectively for the purpose of standardizing their presentation across each of the military services and does not imply the categories have discrete boundaries.

1. Theater Communications Systems

The Navy's theater communications is provided by the Navy Telecommunications System (NTS). Its shore-based facilities form the Navy's terrestrial backbone communications architecture. This architecture allows users, onboard deployed ships, remote access to strategic communications networks using various onboard ship-to-shore communications systems. Other NTS ship-to-shore (theater communication) used in the Navy include the following: [Ref. 31: pp. 82-111]

- Fleet broadcast system
- ORESTES
- Satellite communications
- Secure voice communications
- Officer-In-Tactical-Command Information Exchange System (OTCIXS)
- Tactical Information Exchange System (TADIXS)

The main purpose of NTS is to facilitate the C2 process from the NCA down to commanders of deployed CVBGs and task forces. This is accomplished by providing users with secure and reliable telecommunication services during contingency operations or wartime scenarios.

a. NTS Shore Facilities

The three major types of shore-based communication facilities that support Naval shore commands and ship/shore communications requirements are Naval Computer and Telecommunications Area Master Stations (NCTAMS), Naval Computer and Transmission Stations (NCTS), and Naval Telecommunications Centers (NTCC). These facilities allow the exchange of various types of information such as automated message traffic, secure and nonsecure voice, C2, and intelligence. [Ref. 6: p. 6-19]

The NCTAMS is normally the largest and most well equipped shore-based communication facility that is located in one of four geographical regions. These geographical regions are Eastern Pacific, Western Pacific, Atlantic, and Mediterranean. Although the main function of the NCTAMS is to control and track the status of other NTS facilities within their region, they are capable of

performing other support functions as shown below: [Ref. 6: p. 6-19 and Ref. 31: p. 80]

- Support full period ship/shore terminations
- Perform re-keying of fleet broadcasts
- Facilitate HF communications
- Provide user interconnectivity to services offered by the Defense Communications System (AUTODIN, DSN, DDN, etc.)

The Naval Communications and Transmission Stations (NCTS) are smaller facilities compared to the NCTAMS, but still provide the basic support functions listed above. These interconnected facilities make up the preponderance of the NTS network. Both the NCTAMS and NCTS have transmission and receive communications equipment that connect Naval shore commands and deployed fleets with long-haul DCS services. [Ref. 6: p. 6-19]

The Naval Telecommunications Centers (NTCC) are similar to the NCTS, but lack the communications capability to transmit and receive ship-to-shore message traffic. Their main function is to provides its customers with over-the-counter message services.

b. Fleet Broadcast System

The Navy's fleet broadcasting system disseminates (one-way) record traffic between shore commands, shore facilities and deployed fleets, and among ships at sea. Broadcast transmissions are controlled by the Broadcast Control Authority located at the regional NCTAMS. Two types of software programs that provide interfacing with Defense Information System Agency's (DISA) communications networks and automated switching centers are the Naval

Communications Processing and Routing System (NAVCOMPARS) and the Local Digital Message Exchange (LDMX). The NAVCOMPARS, located at NCTAMS, interfaces with the fleet broadcasting system to maintain message reliability, accuracy, and control for messages transmitted to and received from the fleet. For example, the NAVCOMPARS translates messages received from the fleet by using a Common User Digital Exchange System (CUDIXS) that converts the message into a format compatible with the AUTODIN network. The LDMX, located in the NTCC, is similar to the NAVCOMPARS, but does not interface with the fleet broadcasting system. This system is commonly used to manage and control high volume message traffic only between the Naval shore commands. The type of fleet broadcasts and their means of communication are driven by users' specific needs and requirements. Table 8 summarizes some of the common types of fleet broadcasts and methods of communications. [Ref. 7: pp. 24-25 and Ref. 32: p 5-16]

c. ORESTES (High Frequency)

The ORESTES is the Navy's teletype system that supports the transmission of message traffic over HF radios. Due to the long range capabilities offered by HF communications, this system is often used to add redundancy to high priority Ultra High Frequency Satellite Communication (UHF SATCOM) links. The two ship/shore channels this system uses are the Primary Ship-to-Shore (PSS) channel and the Secondary Ship-to-Shore (SSS) channel. The main difference between PSS and SSS is that PSS communicates with Radioteletype Systems (RATT) using HF skywave propagation, where as the SSS communicates with RATT using continuous wave. The ORESTES is normally used an alternate system, due to both the large electronic signature emitted from its high powered HF radios and its inherently low transmission data rates. [Ref. 7: pp. 27-28]

TYPE OF BROADCAST	PURPOSE
Multicast Broadcast system (MULTICAST)	- Support simultaneous transmission of the fleet broadcast over HF and UHF SATCOM to users at sea. - Primary means of delivering the fleet broadcasts - Types of information: OPINTEL, weather, GENSER Record traffic.
Single Broadcast system	- Transmits the fleet broadcasts to ships with simpler communications systems.
Facsimile Broadcasts	- Transmission of weather pictures
Mercast	- Continuous wave transmission of government messages to Material Sealift Command and Merchant vessels.
VP Broadcasts	- Fleet broadcast transmission over HF to ASW Patrol Aircraft and their operation centers.
TACAMO Broadcast	- Relay emergency action messages to submerged submarines using LF communications.
Patrol Gunboat Broadcast	- Transmit message traffic to patrol gunboats over primary ship-to-shore circuits using HF communications.
Submarine Broadcast	- Transmitting messages using the VERDIN (operating in the VLF frequency range) to deployed submarines.

Table 8. Common Types of Fleet Broadcasts. [Ref. 7: pp. 22-24]

d. Satellite Communications

Satellite communications are the Navy's primary means of supporting its high priority communications between shore commands and the deployed naval forces. Today's naval satellite communications use four types of satellites which are GAPFILLER satellites, leased satellites (LEASAT), fleet satellites (FLTSAT), and Defense Satellite Communication System (DSCS) satellites. The DSCS satellites were discussed in Chapter II.

(1) GAPFILLER Satellites. The UHF GAPFILLER satellites, launched in 1976, acquired their name by filling in coverage gaps that previously existed among naval communication systems. Although the Navy originally launched three GAPFILLER satellites, currently only one remains in use today. [Ref. 31: pp. 100-101]

(2) Leased Satellites (LEASAT). LEASAT are commercial satellites leased by the government for a period of five years to replace the aging GAPFILLER satellites. The primary purpose of these UHF satellites are to maintain user connectivity between mobile and shore-based facilities. [Ref. 31: p. 102]

(3) Fleet Satellites (FLTSAT). The FLTSAT consists of five government owned satellites. They have either Super High Frequency (SHF) or Extremely High Frequency (EHF) capabilities and provide communications support for both the Air Force and the Navy. The use and channel allocations for FLTSATs are determined by the CINC Fleets (CINCFLTs), NCTAMS, and the Commander of Naval Computer and Telecommunications Command (NCTC). Some of the services supported by FLTSAT include the following: [Ref. 31: pp. 101-102]

- Fleet broadcasting system
- Common User Digital Information Exchange System (CUDIXS)/Naval Modulated Automated Communications System (NAVMACS)
- Secure voice
- Submarine Satellite Information Exchange Subsystem (SSIXS)

The Common User Digital Information Exchange System (CUDIXS) and the Naval Automated Communications System (NAVMACS) are two systems supported by FLTSAT that automate two-way, high volume messages between ships and shore. The CUDIX is located in the NCTAMS or NCTS. This system receives messages sent from sea and forwards them to the Naval Communications Processing and Routing System (NAVCOMPARS) where they are translated and injected into the AUTODIN network. The CUDIXS has the capability to handle 60 received messages simultaneously by using time division multiplexing. The NAVMACS is the ships' onboard counterpart of CUDIXS. The goal of both systems is to minimize the amount of information passed over the PSS channels of HF communication system. [Ref. 31: pp. 88-89 and Ref. 32: p. 5-15]

The Tactical Intelligence Computer System (TACINTEL) is another subsystem to the UHF FLTSAT communications. It is similar to NAVMACS, but is normally used only to process and distribute intelligence related messages. The system operates along with the CUDIXS system for transmitting messages up to the Special Intelligence Information (SCI) security level. [Ref. 6: p. 5-20]

e. Secure Voice

The Navy's satellite communication systems (GAPFILLER, LEASAT, and FLTSAT) provide the transmission media needed to extend secure voice communications to highly dispersed common users and dedicated subscribers. The satellite links will connect the users afloat to shore-based facilities (NCTAMS and NCTS), thus acting as communication gateways into the Defense Switching Network (DSN). The DSN is one of several long distance services provided by the DCS. To support its high volume requirements over limited satellite links, Demand Assigned Multiple Access (DAMA) techniques are

often employed. This technique performs time division multiplexing of both voice and data circuits to allow users simultaneous access over the same communications link. For example, to support situations that call for additional voice circuits, DAMA will multiplex these voice circuits with dedicated tactical intelligence (TACINTEL) circuits to meet the communication requirements. [Ref. 7: pp. 31-33]

f. Officer In Tactical Command Information Exchange System (OTCIXS)

OTCIXS is a two-way communication system designed to pass targeting, fire support, and intelligence record traffic over UHF satellite links between battle group elements and key shore sites. These key shore sites include: Fleet Ocean Surveillance Centers (FOSIC), Fleet Ocean Surveillance Facilities (FOSIF), and Shore Targeting Terminals (STT). The system supports over-the-horizon tactical targeting efforts, especially for precision guided munitions like the Tomahawk cruise missile. OTCIXS is commonly found on most combatant ships and some designated submarines. In the future, the new Advanced Combat Direction System (ACDS) will replace OTCIXS and similar systems. [Ref. 32: p. 6-66]

g. Tactical Data Information Exchange System (TADIXS)

TADIXS, similar to the OTCIXS, is a dedicated broadcast channel used for communicating between shore sites and ships equipped with cruise missiles. This system is normally located in the NCTAMS and provides deployed ships with targeting information. One should not confuse this TADIXS with the Coprenican TADIXS. The Coprenican TADIXS is a series of tactical virtual nets that form one of four pillars of the Coprenicas architecture. The others included in

this architecture, but exceed the scope of this thesis, are the Global Information Exchange System (GLOBIXS), the Commander in Chief (CINC) Command Complex (CCC), and the Tactical Command Center (TCC). [Ref. 31: pp. 36-140]

2. Tactical Communications Systems

Tactical communication systems are systems that are generally used for localized C2, relative to the theater of operations, to support immediate combat operations. This category may consist of ship-to-ship, submarine-to-submarine, ship-to-submarine, and ship-to-aircraft communications. As a caveat, many of the systems previously categorized as theater communication systems may also support tactical user requirements. Other systems such as tactical voice systems, Submarine Satellite Information Exchange Subsystems (SSIXS), and Tactical Information Digital Data Links (TADIL) may be used in lieu of, or in conjunction with, theater communications systems. Tactical communication systems support the real-time exchange of voice and data, essential to maintaining C2 over highly mobile forces in a rapidly changing environment.

a. Tactical Voice Systems

Tactical voice communications among deployed forces primarily use both HF and LOS UHF/VHF communication equipment. HF radios are often used to communicate with stations located over-the-horizon when UHF/SHF satellite systems are unavailable. Conversely, UHF/VHF radios are used to maintain secure voice communications with deployed aircraft and other ships/submarines that remain in LOS. As mentioned earlier, one limitation associated with HF communications is that HF radios transmit a much larger electronic signature than UHF/VHF communications, thereby assisting hostile efforts for direction finding. Table 9 displays some examples of commonly used voice nets and their functions.

VOICE NET	FUNCTIONS	METHODS OF COMMUNICATIONS
Secure Voice Command Net	Coordination and information transfer between the OTC and his warfare commanders	UHF Satellite, HF (back-up)
Scene of Action Command Net	Tactical C2 of surface action groups (SAG)	UHF LOS Radio, HF (back-up)
Battle Group Tactical Net	Tactical C2 for maneuvering of the battle group and screening operations	
AAW Coordination and Reporting net	AAWC and AAW/AEW units for reporting and control	
AAW Reporting Net	A means to report AAW contacts	
ASW/ASUW Coordination and Reporting Net	ASW/ASUW units coordinate and report all surface and subsurface contacts within LOS range.	UHF LOS only
ASW Air Control	ASW ships and Air Information Center uses net to control and manage air space	
EW Coordination and Reporting Net	EWC controls and tasks EW assets and reports their operational status.	
Air Strike Control Net	AWC and the air strike leader uses to control other strike aircraft.	
ASW /ASUW OTH Coordination and Reporting Net	ASW/ASUW units coordinate and report all surface and subsurface contacts beyond LOS range.	HF only

Table 9. Common Voice/Data Communications Nets. [Ref. 31: pp. 108-109]

These nets are typically used by naval fleet, carrier battle group, and task force commanders to maintain C2 over their assigned forces. [Ref. 31: pp. 107-109]

b. Tactical Data Information Links (TADIL)

TADIL is a group of JCS approved standardized communication links that support the exchange of real-time digital information between a number of major U.S. and NATO C2 systems. The type of specific TADIL used to support air defense and combat operations depends on their use and the type of communication system (HF, UHF, SATCOM, etc.) over which TADIL is passed. The type of TADILs currently available are summarized in Table 10.

c. Submarine Satellite Information Exchange Subsystem (SSIXS)

The primary means of communicating with deployed submarines is by very low frequency (VLF) and low frequency communications. The wavelengths in this frequency range facilitate communications with SSN and SSBN class submarines while submerged at great depths. Additionally, the low frequency ranges require submarines to use long trailing antennas, often greater than ten kilometers, to propagate the large wavelengths. Due to the inefficiency of its very low data rates, this system is normally used as a "bell ringer". The bell ringer method directs submarines to place antennas above the surface of the water, so they are able to receive message traffic, over HF or SATCOM, using the Submarine Satellite Information Exchange Subsystem (SSIXS). The SSIXS supplements existing VLF/Medium Frequency (MF)/HF communication links to submarines by allowing deployed submarines to passively receive regularly scheduled message broadcasts using very high transmission rates. Additionally,

LINK TYPE	PURPOSE	TRANSMISSION METHOD
LINK 4	- One-way data link that controls interceptor aircraft through surface-to-air, air-to-air and air-to-surface computer interface - Intra-task force tactical voice and teletype circuits for C2 related functions	UHF LOS radio
LINK 4A	- Two-way data link with F-14 Tomcat aircraft that enables the fighter to transfer track and ownership status data to the air controller - Intra-task force tactical voice and teletype circuits for C2 related functions	UHF LOS radio
LINK 11	- Intra-task force tactical voice and teletype circuits for C2 related functions	HF, UHF LOS
LINK 14	- One-way link that enables NTDS-equipped ships to communicate surface Combat Direction System (CDS) computer outputs via radio teletype to non-CDS configured vessels. - Intra-task force tactical voice and teletype circuits for C2 related functions	HF, UHF LOS radio

Table 10. Examples of TADILs. [Ref. 6:p. 7-72]

this system supports message and voice transmissions over FLTSATCOM and LEASAT during periods between regularly scheduled broadcasts. By decreasing the submarines' transmission times, they can quickly return to a submerged state, thus significantly decreasing their chances for detection. [Ref. 7: pp. 37-39]

D. SUMMARY

The Navy's primary C4I system is JMCIS. This system supports the objectives of the Navy's strategy to develop a seamless and global C2 architecture called GCCS. The Navy is currently expanding the system's functions, applications, and capabilities to meet rapidly changing C2 requirements of the modern warfighter. To support the five generic C2 functional areas, the Navy applies its key C4I systems such as: NIPS for intelligence, ATEAMS and TAMPS for air operations, TWCS and CDS for fire support, JMCIS (NTCS-A) and CDS for maneuver, and NTCSS for logistics. These C4I systems rely on theater or tactical level communication support systems to exchange information among its users and databases. Theater level communications systems provide communications between deployed ships and non-organic activities. Some of these systems discussed in this chapter were the Fleet broadcast system, ORESTES, satellite communications, secure voice, OTCIXS, and TADIXS. Tactical level communication systems provide communications among the elements of a deployed naval force. Examples of tactical communications discussed included tactical voice, TADIL and SSIXS. The main focus of this chapter was how the Navy applies its C4I system to satisfy the user's C2 functional requirements and how various types of Naval communication systems support its C4I systems in its operational environment.

VIII. MARINE CORPS COMMUNICATIONS

A. INTRODUCTION

Chapter IV identified the MAGTF as the Marine Corps' primary organization that is often tailored to support specific naval/amphibious operations. It also stated that all MAGTF organizations generally deploy as Amphibious Task Forces (ATF) and consists of four primary elements. These elements are a Command Element (CE), an Air Component Element (ACE), a Ground Component Element (GCE), and a Combat Service Support Element (CSSE). To support the MAGTF's tactical and theater level C2 requirements, it must rely on the C4I systems that fall under the MAGTF C4I program. This program is a collective group of automated C4I systems that replaced the older Marine Corps Tactical Command and Control System (MCTCCS) [Ref. 6: p. 7-62]. Some of the key C4I systems that compose the MAGTF C4I program and will be described later in this chapter are listed below: [Ref. 33: p. 15]

- Intelligence Analysis System (IAS)
- Advanced Tactical Air Command Central (ATACC)
- Improved Direct Air Support Central (IDASC)
- Marine Air Traffic Control and Landing System (MATCALS)
- Tactical Air Operations Module (TAOM)
- Marine Advanced Field Artillery Tactical Data System (MAFATDS)
- Position Location Reporting System (PLRS)
- Tactical Combat Operations (TCO)
- Marine Combat Service Support Control System (MCSSCS)

B. MARINE CORPS PRIMARY C4I SYSTEMS

The MAGTF C4I systems presented in this chapter were designed to support the information "pull" concept similar to the Navy's JMCIS. This concept allows Marine commanders to access only information they need from a common database that receives periodic updates from many different input sources. Interoperability between MAGTF C4I systems and JMCIS databases make it possible for users in either the Navy and Marine Corps to access, exchange, and update information between these systems.

As with JMCIS, the Marine Corps migration toward a single consolidated system is driven by Assistant Secretary of Defense C3I mandate directing all of the services to eliminate their stovepipe and legacy systems to support the Office of the Secretary of Defense (OSD) data standardization initiative. To fulfill this objective, the Marine Corps plans to migrate their MAGTF C4I systems first into JMCIS and then later into GCCS. This required the Marine Corps to adopt common core software modules provided by the Unified Build of the GCCS. One of the key objectives for adopting the Unified Build, other than reducing development and maintenance costs, is that it provides full integration and interoperability of C2 functions between the Commander, JTF (CJTF), the Naval Expeditionary Force (NEF), and the MAGTF. The core software provides an automated Command, Control, and Communications Decision and Display System (C3DDS) capable of interfacing across multiple communication circuits, processing standardized formatted messages, and correlating contact reports to produce a consistent surface/air track database. Track data is plotted on situation displays to create real-time tactical decision aides for both Marine and Navy commanders. This capability will facilitate commanders' ability to quickly acquire real-time information, determine feasible courses of action, and make timely decisions. [Ref. 33: pp. 5-6]

C. MARINE CORPS C2 FUNCTIONS

As stated earlier, the MAGTF C4I program encompasses a broad range of automated information systems to support the expanding C2 and tactical decision making needs of today's Marine commanders. Collectively these systems support five key C2 functional areas. The functional areas form a basis to determining the operational value and contribution of each MAGTF C4I system. Recalling from the previous chapter, the five functional areas intelligence, air operations, fire support, maneuver, and logistics.

1. Intelligence

The Marine Corps uses the Intelligence Analysis System (IAS) to support the intelligence functional areas. The IAS provides a tool for intelligence staff officers (G2, S2) at all MAGTF levels, to collect, process, produce and disseminate the commander's critical information requirements. The system fuses into its consolidated database, automated intelligence information received from other systems/centers such as Technical Control and Analysis Center (TCAC), Secondary Imagery Distribution System (SIDS), Joint Services Imagery Processing System (JSIPS), Position Locating Reporting System (PLRS), and Tactical Combat Operations (TCO). Intelligence information is exchanged between the IAS and external sources using HF, VHF, UHF satellite, and terrestrial communications. As an all source reference, IAS offers tactical commanders finished intelligence that is useful in accessing a constantly changing tactical situation. [Ref. 19: p. 27-29 and Ref. 33: p. 18]

2. Air Operations

The four Marine Corps C2 systems that support the air operations functional area are the Advanced Tactical Air Command Central (ATACC), the

Improved Direct Air Support Central (IDASC), the Marine Air Traffic Control and Landing System (MATCALS), and Tactical Air Operations Module (TAOM). Both ATACC and IDASC systems will eventually replace the Tactical Air Command Center (TACC) and its components that the Marine Corps currently uses for their overall airspace management. [Ref. 19: pp. 24-29 and Ref. 33: p. 20]

The ATACC serves as tactical facilities to support Air Component Element (ACE) commanders and their battlestaffs. It provides them with tactical decision aides they need to supervise, coordinate, and execute both current and future tactical air operations over the MAGTF airspace. These decision aides include communications, system processing, data correlation, air tasking generation, and information (graphics and text) displays. Additionally, the system receives and forwards air management information using TADIL A, TADIL B, and NATO Link 11 sent over HF, UHF, VHF (AM and FM), SHF satellite, and terrestrial microwave communications. This capability allows ACE commanders to develop situation awareness and automate the generation, manipulation, and dissemination of Air Tasking Orders (ATO). [Ref. 33: p. 20]

The IDASC is another facility used to plan and control direct air support for the MAGTF ground component. By automating all direct air support requests, this system facilitates the coordination process for air support, deconflicts aircraft with other supporting arms, and controls all aircraft operating in designated airspaces. This facility replaced the older Direct Air Support Center (DASC). [Ref. 33: p. 20]

Marine air wings use the MATCALS to support air operations while in forward deployed areas. This rugged, transportable, self-sufficient system controls all arriving and departing aircraft within a 60 mile radius. These functions are accomplished by the system's surveillance and approach radars connected to a

central control facility. Air traffic control operators interface with MATCALS through their workstations that contain multi-mode displays, communications equipment (UHF, VHF, HF) and cryptographic equipment (for securing TADIL-B and TADIL-C data links). [Ref. 29: pp. 105-106]

The TAOM is a facility/shelter that supports the Marine Corps air defense C2 requirements. It receives input from external sensors, search radars, and Identification Friend or Foe (IFF) systems, then performs the following operations: [Ref. 29: pp. 103-104]

- Performs automatic track correlation, acquisition, identification, classification, tracking
- Evaluates threat and determines weapon selection/assignment
- Receives and processes track information, orders, and statuses acquired from other C2 systems
- Displays on four internal operator consoles real-time air picture of the situation.

3. Fire Support

The primary system for supporting the fire support function is the Marine Advanced Field Artillery Tactical Data System (MAFATDS). This system is basically a Marine Corp version of the Advanced Field Artillery Tactical Data System (AFATDS) that the Army used to replace its older TACFIRE system. Interoperability between the two systems (MAFATDS and AFATDS) allow the MAGTF ground component to fully integrate into the Army's fire control nets using HF, UHF, VHF, and terrestrial microwave communications. The MAFATDS provides Marine fire control elements with fully automated support for planning, coordinating, and controlling fire support assets. These assets normally include mortars, field artillery cannons, rockets, close air support, naval

gunfire, and guided missiles. All echelons from corps to platoon benefit from the MAFATDS capabilities, especially during various operations such as close air support, counterfire, interdiction, suppression of enemy air defense systems, and deep ground operations. [Ref. 19: pp. 28, 31 and Ref. 33: p. 19]

4. Maneuver

Two primary systems the Marine Corps uses to maintain C2 over the MAGTF elements are the Position Location Reporting System (PLRS), and the Tactical Combat Operations (TCO). PLRS supports the MAGTF during ground operations by providing its users with accurate locations necessary to plan and deliver artillery fire, naval gunfire, and air support. In addition, this system offers maneuver forces other useful functions such as enhanced navigation positioning and unit identification. The system operates using UHF radios that link its user terminals into local area master stations. The PLRS master stations are arranged to form a complete autonomous radio network. [Ref 29: pp 131-132]

The TCO is the focal point of the MAGTF C4I network. It provides the commanders, staff, and subordinates the capability to receive, fuse, display, and disseminate C2 information, for both planning and executing phases of an operation. The TCO's located in Combat Service Support Operations Centers (CSSOC), Operations Control and Analysis Center (OCAC), Combat Operations Centers (COC), Tactical Air Command Centers (TACC), and Fire Direction Centers (FDC). The TCO allows data exchange among its terminals by using HF radio or the Tri-service Tactical (TRI-TAC) communications network. [Ref. 28: pp. 46-48]

5. Logistics

The Marine Corps main system for managing logistical support is the Marine Combat Service Support Control System (MCSSCS). This system provides an automated means to collect, analyze, and distribute personnel and logistical information between the components of the MAGTF (CE, CSSE, ACE, GCE) and the Army's Combat Service Support Control System (CSSCS). Communication between these components is typically over HF, VHF, and terrestrial microwave communication systems. The MCSSCS contains logistical databases regarding the statuses of the MAGTF's personnel, configuration, and equipment. [Ref. 19: pp. 28-31]

The MAGTF C4I systems introduced in this section can be tailored to meet the Marine Commander's unique C2 requirements. The number and specific C4I system configurations are driven by the MAGTF's assigned mission, organization, and asset availability. Although there are other C4I systems and subsystems that currently exist in the Marine Corps, this thesis mainly presents the candidate systems most likely to be selected for retention as legacy or migratory systems. These C4I systems will eventually merge into the Navy's JMCIS, as part of their ongoing effort create a Global C2 System (GCCS).

D. MARINE CORPS COMMUNICATION SUPPORT SYSTEMS

MAGTF C4I systems exchange critical information using various types of communications systems such as HF, UHF, VHF, UHF and SHF satellite, and terrestrial communication networks. Asset availability, communication distances, type of MAGTF C4I system, and phases of the amphibious operation are primary factors that determine the type of communication support systems requied.

The amphibious operations described in Chapter IV, are generally conducted in three basic phases. These are the preparation phase (Marine forces

embarked onboard their ships, prior to an amphibious assault), the movement to shore phase, and the sustainment phase.

Like the earlier discussion on Naval communication support systems, the Marine Corps communications are categorized into two broad categories: theater and tactical communication systems. Theater communication systems are those systems, often used in the communications zone, that bridge tactical networks with strategic communications systems (DCS). These systems extend C2 from the NCA down to the deployed MAGTF. Tactical communication systems are localized communication systems, commonly used in the combat zone, to provide "close in" communications among the MAGTF's internal components. For example, tactical communications systems include those systems between the CATF and the landing force (while afloat and during movement ashore), between the CATF and tactical multichannel networks (established ashore to support follow-on land operations), and between deployed aircraft and their air control elements.

1. Theater Communications Systems

Theater communication support systems may provide connectivity between the Commander of an Amphibious Task Force (CATF) and the Commander of the JTF (CJTF), Marine Corps Component headquarters, and Naval shore commands, during the preparation and movement to shore phases of an amphibious operation. Due to the geographical dispersion of these elements, over-the-horizon communications systems are often required. This is accomplished by using transportable UHF/SHF/EHF satellite, HF radio, the fleet broadcast system, and other existing naval communication systems. In addition, Common User Digital Information Exchange (CUDIX) UHF satellite equipment and HF radios provide the Amphibious Task Force (ATF) connectivity to shore-based NCTAMS and

NCTS. This gives the ATF seamless access to strategic DCS communications services, like DSN, DDN, and DMS. Once the amphibious landing force completes its transition to shore, Ground Mobile Force Tactical Satellite Communications (GMF TACSAT) equipment, such as the AN/TSC-85 and AN/TSC-93 GMF TACSAT terminals, provide the MAGTF command element with long-haul communication capabilities. The GMF TACSAT terminals connect the terrestrial communication network (tactical) established ashore to theater DCS gateways and other Army, Air Force, and Allied communication networks. [Ref. 6: p. 6-26]

2. Tactical Communications Systems

Tactical communication support systems generally include both tactical radio and forward established terrestrial networks ashore. During the preparation phase of an amphibious operation, tactical radio communication systems, such as LOS VHF single channel and HF radio communications (as a back-up), give the CATF a means to exercise C2 over other elements of the ATF. These systems support the exchange of secure voice and data essential for coordinating and executing the preparation phase of the operations. Similarly during the movement to shore phase, the CATF who is often loitering offshore, continues to rely on tactical radio communications to maintain C2 over the landing force transitioning to shore. [Ref. 32: pp. 5-20 to 5-22]

After the majority of units of the landing force have arrived on shore, the Marine communication support units begin installing a tactical multichannel network with their organic TRI-TAC communications equipment. The TRI-TAC network interconnects the primary force components (CE, GCE, ACE, and CSSE) with their subordinate headquarters. By using a combination of UHF multichannel microwave radios, troposcatter radios, or Ground Mobile Forces Tactical Satellite

(GMF TACSAT), the network interconnects Unit Level Circuit Switches (ULCS). The ULCS provide local subscribers with secure voice, facsimile, data and message communication support. [Ref. 6: pp. 6-25 to 6-26]

At lower levels of command, the primary means of communications is the Single Channel Ground Air Radio System (SINCGARS). SINCGARS is a VHF single channel frequency hopping FM radio, with significant anti-jam features, capable of transmitting and receiving both secure voice and data. [Ref. 6: p. 7-62]

The SINCGARS ability to operate in a jamming environment was tested during the Persian Gulf War, when the Iraqi Army launched a surprise attack on Marine Task Force Shepherd near the Kuwait-Saudi Arabia border. During this attack the Iraq Army attempted unsuccessfully to jam the Marines SINCGARS radios. As a result the Marine were able to maintain C2 over their unit and concentrate their firepower to block the advancing Iraqi force. [Ref. 34: p. 9]

E. SUMMARY

The Marine Corps main C4I modernization initiative contributing to the implementation of the C4IFTW concept and the development of GCCS is called the MAGTF C4I program. This program capitalizes on the common core software modules contained in block I of GCCS and its common operating environment (COE) to leverage the Marine Corps' migration of the MAGTF C4I systems. Also presented in this chapter were key C4I systems in the MAGTF C4I program and how they support the five C2 functional areas. These systems and their associated C2 functional areas were outlined in the following manner: IAS supported intelligence; ATACC, IDASC, MATCALS, and TAOM supported air operations; MAFATDS supported fire support; PLRS and TCO supported maneuver; and MCSSCS supported the logistics functional area. The Marine Corps' theater and tactical communication support systems provide CATF, CJTF, Naval shore

commands, and MAGTF components with connectivity necessary to exchange critical information among their C4I systems. Theater level communications systems allow the deployed MAGTF to gain access to long-haul communication systems such as DCS. Tactical communication systems, such as the TRI-TAC network, interconnect the components of the MAGTF and provide Marine commanders localized C2 over their maneuver forces. The combination of modern C4I systems and their communications support systems give the MAGTF the C2 flexibility needed to win on tomorrow's fluid and dynamic battlefield.

IX. AIR FORCE COMMUNICATIONS

The Air Force's overall C4I architecture is called the Theater Air Control System (TACS). It is composed of a number of C4I systems the Air Force uses to employ, manage, and control its aircraft and ground facilities within an assigned theater of operations. This chapter describes the principal C4I systems that support TACS and other major C4I systems that support, not only the Air Force, but other services and Allied Forces. To complete the discussion on the Air Force's C4I systems, requires a presentation on their application to the five C2 functional areas and their communication support systems.

A. AIR FORCE'S PRIMARY C4I SYSTEMS

The two principal C4I systems that automate the C2 functions and processes within TACS are the Contingency TACS Air Planning System (CTAPS) and the Wing Command and Control System (WCCS). CTAPS is used at theater/force level, where as WCCS is used at wing/unit level. In addition to these systems, the Air Force is responsible for four other major C4I systems which include Rivet Joint, Airborne Warning and Control System (AWACS), and Contingency Airborne Reconnaissance System/Joint Service Imagery Processing System (CARS/JSIPS), and Joint Surveillance Target Attack Radar Set (JSTARS). Due to their significant contributions to the theater level C2 process, they will also be treated and discussed as primary Air Force C4I systems. [Ref. 28: p. 32, 36]

1. Contingency TACS Air Planning System (CTAPS)

In April 1992, the Joint Chiefs of Staff (J6) identified the CTAPS as the objective system for supporting the JFACC. The approval by the Joint Chiefs of Staff approval for the JFACC concept has encouraged all of the military services

to adopt CTAPS as their primary air control system. The concept states that the military service having the preponderance of air assets in a theater, will be designated as the JFACC. The JFACC will need CTAPS to fulfill his/her roles in planning, coordinating, allocating air resources, and tasking subordinate organizations, based on guidance received from the JTF commander. [Ref. 33: p. 2]

CTAPS supports the Air Force's centralized control and decentralized execution warfighting philosophy introduced in Chapter IV. The assigned JFACC will use CTAPS to centralize detail planning, tasking, and control of air assets in his/her area of operations. Once the JTF commander approves the JFACC's recommended Master Attack Plan (MAP), he/she will decentralize the execution by issuing Air Tasking Orders (ATO) to subordinate commanders. These ATOs will be more specific in content than the MAP to include details on targets, specific aircrew assignments, available reconnaissance support, and AWACS coverage areas. [Ref: 33: pp. 4-7]

Two other factors that lead to joint implementation of CTAPS as a favored air control system was its capability to resolve interoperability problems that plagued U.S. forces in the Persian Gulf and its evolutionary modular composition. During the initial phase of the Gulf War, the JFACC (Air Force) experienced limited flexibility to change or modify ATOs sent to Navy units, especially after receiving updated intelligence information. These delays were caused by incompatible communications hardware and software that could not receive CTAPS generated ATOs transmitted from the JFACC in Riyadh to the Red Sea battle force. This situation forced the Navy to pick up and deliver ATOs on diskette using messengers from its deployed carriers. The impact of these delays hindered the effective application and control of naval airpower during the early phases of the operation. To minimize future interoperability problems, CTAPS

has been designated as the objective joint system that all JFACCs will use to disseminate air control and tasking orders. Since CTAPS is based on an open system architecture, consisting of high-speed computer workstations connected by a Large Area Network (LAN), it eliminates many of the earlier interoperability problems that previously existed among the services. For example, CTAPS supports the ATO generation and dissemination process among the military services by interfacing with the Army Maneuver Control System (MCS), the Naval Tactical Command System-Afloat (NTCS-A, now part of JMCIS), and the Marine Corps Advanced Tactical Air Command and Control System (ATACC). [Ref. 33: pp. 3-5 and Ref. 34]

Its modular design provide users with core capabilities required to support the air control C2 functional area that will be explained later in this chapter. The modular design further allows the system to be easily tailored to support the users' changing C2 requirements. [Ref. 34]

At the center of CTAPS lies a common set of core software functions that provide a mechanism for integrating "mission oriented" applications used at different Air Force command levels, other military services, and Allied Forces. This set of common core functions is called the Theater Battle Management (TBM) core. Some examples of the services they generally provide include the following: [Ref. 34 and Ref. 35: pp. 2-3]

- Communications
- Message preparation and parsing
- Man-machine interface
- Email
- Security

- Systems administration and management
- User utilities (data distribution and diagnosis, help, system configuration, etc.)

2. Wing Command and Control System (WCCS)

The WCCS is the Air Force's C4I system used at the Tactical Air Force (TAF) wing/unit level. It is an automated system that shares the same TBM core functions and common operating environment as CTAPS, thereby allowing full interoperability between its tailored software applications and those used by CTAPS. A few examples of software applications (systems) used in WCCS and interface with CTAPS are the Air Force Mission Support System (AFMSS), Combat Intelligence System (CIS), Manpower Personnel Module (MANPER), Combat Ammunition System-Base (CAS-B), and Logistics Module (LOGMOD). [Ref. 28: p. 36 and Ref. 36: pp. 2-3]

The overall objective of WCCS is to provide TAF commanders with an accurate composite picture of the wing's resources for planning and executing air operations. To achieve this objective, WCCS must perform a wide variety of data processing tasks to support: aircraft scheduling, execution/implementation of air plans, maintenance statuses, alerts, personnel management, weather assessments, vehicle statuses, and munitions availability statuses. [Ref. 19: p. 22]

Collectively. CTAPS and WCCS automate the C2 processes and functions performed by the theater operational chain of command when employing air assets. The benefit of automating these processes allow the JFACC and TAF commanders to accurately view the tactical situation and asset availability, make timely decisions, and quickly disseminate ATO's to subordinate units.

3. Rivet Joint C4I System

The Rivet Joint C4I system is a E-135 reconnaissance aircraft equipped with onboard communication systems the Air Force uses to receive and process long-range early warning Signal Intelligence (SIGINT) and Electronic Intelligence (ELINT). After detecting hostile communication and electronic signatures, the system aides in the analysis of this information to determine the enemy's electronic order of battle, force identification, and unit locations. This system communicates with command posts over TADIL J communications links by using UHF/VHF/HF radios. [Ref. 19: p. 16]

4. Airborne Warning and Control System (AWACS)

The AWACS is a wide-area surveillance system that aides primarily in the control of air defense weapons and airspace management functions. It is composed of nine multi-purpose operator consoles, secure communications systems, and an IFF/SSR multimode radar mounted onboard a modified Boeing 707 (E-3) aircraft. The AWACS scans its coverage area using its IFF/SSR radar, mounted in a mushroom shaped housing above the fuselage. Several key features of the AWACS include its capability to transmit a comprehensive air picture to ground facilities and perform target cuing for other targeting and tracking systems. This system provides critical surveillance information into C4I systems owned by the Air Force, other services, and selected Allied Forces. [Ref. 29: pp. 257-258]

5. Contingency Airborne Reconnaissance System/Joint Service Imagery Processing System (CARS/JSIPS)

CARS is an airborne platform that forwards SIGINT, imagery, and target data to ground-based JSIPS terminals for further processing and dissemination by C4I systems. JSIPS terminals may also receive imagery and target data over

tactical data links from other surveillance systems such as U2-R aircraft, unmanned aircraft, and other national systems. Inside shelters housing the JSIPS terminals, military personnel collect, correlate, analyze, and prioritize received intelligence data, prior to reformatting it for further dissemination over electronic media. [Ref. 37: pp. 1-3]

6. Joint Surveillance Target Attack Radar System (JSTARS)

JSTARS is a long-range airborne surveillance system, onboard an E-8 aircraft, that is capable of detecting, identifying, locating, and tracking both ground and airborne enemy activities in deep operational areas (beyond the Forward Line of Troops). Its advanced electronics allow the system to perform these functions during any type of weather and while operating in a jamming environment. Collected surveillance information is forwarded down to Army operated ground stations and C4I systems over TADIL J communications links. This provides Army commanders a means to optimize targeting for long-range fire support. Air Force command posts maintain operational C2 over JSTARS assets by using UHF/VHF/HF radio communications from its ground control stations and centers. [Ref. 38: pp. 266-267]

B. AIR FORCE FUNCTIONAL AREAS

The Air Force, like the Army and Marine Corps, relies on TRI-TAC networks and tactical radio communications to link their key C4I information/management systems. These systems must collectively work together to support tactical decision makers with the five C2 functional areas. The following paragraphs describe these C4I systems and their related C2 functional areas.[1]

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[1]The astrict (*) denotes systems that support multiple C2 functional areas.

1. Intelligence

The primary CTAPS software component for collecting, managing, and exchanging intelligence information is the Combat Intelligence System (CIS) located in the AOC, ASOCs, and WOCs. CIS consolidates the software functions from Rapid Application of Air Power (RAAP), Intelligence Correlation Module (ICM), Sentinel Byte, and Constant Source (CS) to support air operations at the theater (force) and tactical (unit) levels. The system automates the correlation of near-real time data from message traffic to continually update its threat database. CIS, in conjunction with the other systems listed below, provide the JFACC with a common (fused) picture of their battlespace that can be shared with the other services and Allied Forces. This information is displayed on a Tactical Information Situation Display (TISD). The other systems that contribute and support this functional area are: [Ref. 39: pp. 2-4]

- Automated Weather Dissemination System (AWDS - application of WCCS used at the wing/unit level)
- Combat Air Forces Weather Support Program (CAFWSP-used in the ASOC and AOC)
- Improved Many-on Many (IMOM - for electronic combat analysis in the AOC)
- Contingency Airborne Reconnaissance System/Joint Services Imagery Processing System(CARS/JSIPS)
- Rivet Joint System
- U2-R Reconnaissance Aircraft (collects signal and imagery intelligence)
- Airborne Warning and Control System (AWACS)*
- Joint Surveillance Target Attack Radar System (JSTARS)*

2. Air Operations

The key systems that support the air operations C2 functional area are the Automated Planning System (APS), the Computer Assisted Force Management System (CAFMS), the Airspace Deconfliction System (ADS) and the Air Force Mission Support System (AFMSS). These systems are software applications in CTAPS for planning future air operations, airspace management, creating airspace control orders, and producing air tasking orders (ATOs). [Ref. 28: pp. 72-73 and Ref. 34]

At the Air Component (force) level, the APS assists the Combat Plans Division in the Air Operations Center (AOC) build force packages by performing the following functions: [Ref. 34]

- Comparing desired force levels with available resources
- Requesting, receiving, maintaining, and analyzing intelligence data
- Conducting risk assessments
- Assessing logistical and weapon statuses
- Estimating expected flight times of the mission

The APS produces an air coordination order (draft air tasking order) that the Combat Plans Division uses with other information provided by the ADS to plan future air operations. During the execution phase of the mission, the APS produces the actual ATO then relies on CAFMS to manage and disseminate it to the appropriate unit or services. This system provides pilots with a comprehensive, well-coordinated, and deconflicted air plan. The AFMSS performs similar functions as the APS, but at the wing/unit level. [Ref. 28: p. 37 and Ref. 34]

3. Fire Support

The Joint Munitions Effectiveness Manual (JMEM) and the CIS (RAAP functions) are the primary fire support applications in CTAPS. Air Force operational planners rely on the JMEM to assist them in determining which type of weapon they should employ. Targeteers use this information, along with target data correlated and managed by RAAP, to determine actual target nominations. Fire support information is then forwarded to combat planners, so they can construct the ATOs. Other systems that contribute to the fire support functional area include: [Ref. 28: pp. 37, 73]

- Target Plotting and Verification Module (TPVM - used in the ASOC)
- Joint Surveillance Target Attack Radar System (JSTARS)*
- Airborne Warning and Control System (AWACS)*

4. Maneuver

The primary component of the CTAPS the Air Force uses for maneuver is the Route Evaluation Module (REM). This software application performs a route analysis that assist combat planners in determining optimal avenues of approach to selected targets. Other systems that support the maneuver C2 functional area include: [Ref. 28: p. 72]

- Advanced Planning System (APS - used at the Air Component level)*
- Modular Control Equipment (MCE - automated system for controlling and coordinating the employment of aircraft and air defense systems)

- Air Force Mission Support System (AFMSS - used at wing/unit level)*
- Airborne Warning and Control System (AWACS)*

5. Logistics

The Logistics Module (LOGMOD) is an automated system the Air Force uses to track, record, and manage logistical support requirements. The system also keeps track of the status of all available resources. LOGMOD is a subsystem of CTAPS, as well as, part of the WCCS. Other WCCS subsystems that collectively support the logistics C2 functional area include: [Ref. 28: pp. 37, 73]

- Consolidated Aircraft Maintenance System (CAMS)
- Combat Ammunition System-Base (CAS-B)
- Manpower and Personnel Module (MANPER)
- Air Force Operational Resource Management System (AFORMS)

The five C2 functional areas, just presented, require full integration and interoperability among a variety of CTAPS software applications. These CTAPS subsystems, in conjunction with other independent C4I systems such as AWACS, JSTARS, Rivet Joint, and CARS/JSIPS, must continually share a common tactical picture to JFACC and Air Force commanders at all levels. This provides them with reliable, consistent, and timely information necessary to enhance their decision making process.

C. AIR FORCE COMMUNICATION SUPPORT SYSTEMS

In order to maintain consistency and standardization, this thesis describes the various Air Force C4I systems by again categorizing them into two broad categories: theater and tactical communication systems.

1. Theater Communication Systems

Theater level communication systems are systems that connect the Air Force's key C2 facilities which are often geographically dispersed throughout the theater of operations. These facilities include the JTF headquarters, the Joint Forces Air Component Commander (JFACC), the Air Operations Center (AOC), the Mobile Air Operations Centers (MAOC), Forward Air Control Posts (FACP), Control and Reporting Centers (CRC), Control and Reporting Posts (CRP), and Air Support Operations Centers (ASOC). Two examples of theater communications systems include the Air Force's TRI-TAC network and long-haul satellite links into strategic DCS communications network. [Ref. 28: pp. 34-35]

Air Force units deployed into a theater of operations are supported by Combat Communications Groups (CCG) and Combat Communications Squadrons (CCS). These organizations collectively have the responsibility of installing a reliable, robust, and secure terrestrial communications network consisting of an assortment of TRI-TAC communication assemblages. The system's circuit and message switches, such as the AN/TTC-39 and AN/TYC-39 respectively, are often collocated at key operations centers/posts to provide local subscribers with common user voice, message, and data communications. The TRI-TAC switches may also interface with other terrestrial networks installed by the Army, Marine Corps, and Allied forces. Connectivity between the TRI-TAC switches is normally accomplished by using troposcatter and UHF LOS microwave transmission systems. In some cases, such as in Desert Shield/Desert Storm,

operation centers/headquarters may be dispersed at great distances, thereby creating a need for single and multichannel Ground Mobile Forces Tactical Satellite Systems (GMF SATCOM). The AN/TSC-94 and AN/TSC-100 are two types of GMF SATCOM terminals commonly employed by the Air Force. They provide users connectivity to TRI-TAC switches allowing them to communicate through the tactical multichannel network. The Air Force's operation centers/posts may use either GMF SATCOM or troposcatter communications equipment for connectivity to other TRI-TAC message and circuit switches positioned near DCS entry stations. These entry stations give users access to strategic DCS services such as DMS, DDN, and DSN. Regardless as to whether the Joint Force Air Component Commander (JFACC) operates from a fixed AOC or mobile AOC (MAOC), the DCS network can provide them with extended or "reach back" capabilities to CONUS based commands. This is achieved by using DSCS, commercial, or leased satellites. An example of a CONUS based command is the Air Combat Command (ACC) at Langley Air Force Base, Virginia. [Ref. 6: pp. 5-17 to 5-19]

2. Tactical Communication Systems

The Air Force's tactical communication systems include the service's VHF/UHF LOS single channel or HF radio communication systems that support C2 between all deployed aircraft (including theater level airborne systems) and their ground control elements such as the AOC, TACPs, CRCs, FACPs, CRPs, and WOCs. For example, the radio communications between an attack aircraft providing close air support (CAS), air interdiction, and other related missions in support of Army ground forces, are categorized in this thesis as tactical communication systems.

The Air Force supports Army ground operations by collocating Tactical Air Control Parties (TACPs) that consist of Air Force liaison personnel assigned to the Army's Tactical Operation Centers (TOCs) at division, brigade, and battalion levels. Although these personnel generally use tactical VHF/UHF radios to communicate directly with supporting aircraft, they must also rely on the Army's Mobile Subscriber Equipment (MSE) network to coordinate with their parent ASOC collocated with the corps TOC. To add further redundancy to these communication links, as well as, support other long-range, over-the-horizon communication requirements, the Air Force uses its organic HF radios. [Ref. 6: p. 5-19]

D. SUMMARY

The two principal Air Force C4I systems described in this chapter were CTAPS and WCCS. They automate many of the C2 functions and processes within TACS to support commanders at the force/theater and wing/unit levels. The CTAPS is a migratory system that has an open architecture and a common operating environment, similar to the C4I systems (JMCIS and MAGTF C4I) described in previous chapters. The system's key function is to support the JFACC with an automated mechanism for developing and disseminating ATOs to subordinate units, the other services, and Allied Force. At the wing/unit level, the WCCS shares the same TBM core functions as CTAPS, in order to, promote interoperability among the two systems. Also described in this chapter were four C4I systems to include the Rivet Joint, AWACS, CARS/JSIPS and JSTARS. These systems are capable of managing and disseminating real-time tactical pictures of the commanders' battlespace during joint warfare operations.

Air Force's C4I systems presented in this chapter support one or more C2 functional areas. The primary C4I systems that supports each functional area were

identified as: CIS for intelligence; APS, CAFMS, ADS, and AFMSS for air operations; JMEM and RAAP for fire support; REM for maneuver; and LOGMOD for logistics functional area.

Similar to the other services, communications systems that support the Air Force's C4I systems were categorized as either theater or tactical communications. The Air Force relies on its organic TRI-TAC communication network and GMF SATCOM terminals to support theater level commands, as well as, provide long-haul connectivity into strategic communications networks, like DCS. At the tactical level, the Air Force generally uses its VHF, UHF, and HF radios to communicate voice and data between controlling ground stations and deployed aircraft.

Although not specifically addressed, the Air Force's ongoing C4I initiatives are outlined in their service's strategy called the Horizon. This strategy outlines how the Air Force will migrate and consolidate many of its stovepipe C4I information systems into the CTAPS to support the Department of Defense's ultimate goal of creating a joint C4I architecture (GCCS). Eventually CTAPS, AFMSS, and other C4I systems will merge into a single C4I system called the Air Force Global Command and Control System (AFGCCS). This will form the Air Force's contributing system to a joint C4I architecture that supports a seamless exchange of tactical information to the warfighter.

X. ARMY COMMUNICATIONS

This chapter will present the Army's primary C4I systems used to support the theater and tactical level C2 requirements. Following an executive overview of these systems, this chapter will identify and explain the Army's key C4I systems that directly support the five C2 functional areas. This will be presented in the same manner used previously to describe the C4I systems for the other military services. To complete the presentation on the Army's theater and tactical C4I systems, the various types of communications support systems needed to interconnect these C4I systems will also be discussed.

A. ARMY'S PRIMARY C4I SYSTEMS

The Army's C2 architecture is called the Army Command and Control System (ACCS). It extends C2 from the NCA to the foxhole, by interfacing theater level networks with strategic and national communications systems. The ACCS encompasses all of the C2 systems, communications, hardware components, and software applications, required to implement the Army's AirLand Battle doctrine and support its portion of the Joint Operations Planning and Execution System (JOPES). The three principle C4I systems that compose the ACCS are the Army WWMCCS Information System (AWIS), Standard Theater Army Command and Control System (STACCS), and the Army Tactical Command and Control System (ATCCS). AWIS is the Army's component of WWMCCS (discussed briefly in Chapter II) that supports strategic level C2. In addition, AWIS serves as a brigde between WWMCCS and C4I systems supporting theater and tactical C2, such as STACCS and ATCCS respectively. Both STACCS and ATCCS are treated in this thesis as C4I systems because their composition includes C2, communications, and intelligence processes and

systems. Since the main focus of this thesis is on theater and tactical C4I systems, only STACCS and ATCCS will be discussed in further detail. [Ref. 40]

1. Standard Theater Army Command and Control System (STACCS)

STACCS is a theater level or Echelons Above Corps (EAC) C4I system that provides its users with timely and accurate information, on friendly and hostile force activities throughout the contingency spectrum.[2] Examples of contingencies typically supported by STACCS are peace operations, crisis planning, transition-to-war, and wartime C2 functions. Users of the STACCS are normally theater army commanders and staffs, Army component headquarters, and major command levels. STACCS connects its users' Local Area Networks (LANs) to form a single Wide Area Network (WAN). The WAN gives commanders the capability to rapidly access and exchange critical information needed to support tactical decision making and order dissemination. This information generally includes, theater level communications statuses, staging area activities, force movement, and resource availability status. [Ref. 41: pp. 31-36 and 44-45]

During the Persian Gulf War, STACCS formed a single WAN that connected the LANs supporting the Army Forces Central Command (ARCENT) Headquarters, the forward logistics center at King Kahlid Military City (KKMC), the Support Command (SUPCOM), the Transportation Command (TRANSCOM), the Material Management Command (MMC), the Area Support Group (ASG), and the supporting signal brigade. This WAN was externally connected to the Defense Integrated Secure Network (DISNET) to provide users with secure

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[2]Echelons Above Corps include all command levels at the Army corps level and higher in a theater of operations. EAC typically includes Army major theater commands, theater Army component headquarters, and theater Army support commands.

communications to other headquarters outside the theater, such as U.S. Army Europe (USAREUR), Forces Command (FORSCOM), and ARCENT rear headquarters in the continental U.S.(CONUS). [Ref. 41: p. 34]

STACCS uses common hardware components and a common software operating system that support an open system architecture which can be easily tailored to support specific C2 functional requirements. Some of these functions are listed below. [Ref. 41: p. 40]

- Graphics presentation
- Database management
- File management
- Message processing and control
- Common network management
- Gateway connectivity to other networks

The system is completely interoperable with the Maneuver Control System used at Echelons Corps and Below (ECB). This connectivity allows high level commanders to acquire timely tactical information needed to remain abreast of the tactical situation and exercise effective C2 over widely dispersed theater assets. To meet the near-term objectives of the approved C4IFTW concept, the Army plans to standardize the STACCS basic system architecture (excluding the tailoring of command unique functions) for use in theaters world-wide. [Ref. 41: p. 33]

2. Army Tactical Command and Control System (ATCCS)

The ATCCS is the tactical or Echelons Corps and Below (ECB) portion of ACCS. It serves as an aggregate means by which commanders employ and sustain tactical forces. The architecture of ATCCS consists of five battlefield functional areas (BFA) directly corresponding to the C2 functional areas used throughout this thesis, and three types of communication support systems. The three type of communications support system are Area Common User System (ACUS), Combat Net Radio (CNR), and Automated Digital Data System (ADDS). These systems will be discussed later in this chapter. [Ref. 40]

The BFAs are common at each level of command from corps to brigade. They have been identified by senior military planners as essential for tactical Army commander's to implement the AirLand battle and AirLand Operation doctrines. The ATCCS integrates all of the BFAs to provide a commander the capability to assess the tactical situation, make decisions, disseminate orders, and evaluate the results. [Ref. 40]

The BFAs are supported by C4I systems that manage, exchange, coordinate, synchronize, and process information to support the tactical decision making process. The five Army C4I systems that support ATCCS are the All Source Analysis System (ASAS), the Forward Area Air Defense Command, Control and Intelligence System (FAADC2I), the Advanced Field Artillery Tactical Data System (AFATDS), the Maneuver Control System (MCS), and the Combat Service Support Control System (CSSCS). These systems will be described later in this chapter. [Ref. 40]

Since all of the C4I systems in both ATCCS and STACCS use common hardware and software (ie. Common ATCCS Software System, CASS), they are capable of exchanging data information both vertically and horizontally using force level and functional control systems. Force level control systems provide the

automation to support the horizontal synchronization of the BFAs at each level of command. The horizontal exchange of information extends beyond the immediate organization to include adjacent Army units or other miliary services. Functional control systems integrate similar BFAs vertically between the levels of command. This full integration and interoperability allows information to be fused and rapidly disseminated to expedite a commander's tactical decision cycle. [Ref. 42: pp. 4-8 to 4-9]

The Army strategy to capture advancing technology in communications and support the development of a global C4I system is called the "Enterprise Strategy". Under this strategy, a new system will evolve in the future called the Army Global Command and Control System (AGCCS). It will merge components of STACCS and AWIS into a consolidated C4I system. AGCCS will improve the Army's capability to report, mobilize/demobilize, deploy/redeploy, and sustain its forces during a wide range of contingencies. The system is currently being developed using a modular design, a common operating system, and "tailorable" software applications. Eventually AGCCS, ATCCS and the Brigade and Below Command and Control System (B2C2, a modified extension of ATCCS used at the lower levels) will merge to form the Army's contributing C4I system to GCCS. This system will be called Army Battle Command System (ABCS). The ABCS will permit the warfighter to "pull" from consolidated sources only information needed to support timely tactical decision making. [Ref. 6: p. 6-18]

B. FIVE BATTLEFIELD FUNCTIONAL AREAS (BFAs)

Like those presented for the other services, the Army's five C2 BFA's are intelligence, air operations (air defense), fire support, maneuver, and logistics. Collectively the BFAs form the complete spectrum of a commander's C2 requirements. Each C2 BFA requires one or more specialized C4I system(s) to

perform unique functions. Described below are the Army's basic C4I systems used to satisfy each C2 BFA.

1. Intelligence

The intelligence C2 functional area is supported by the All Source Analysis System (ASAS). This system uses an automated tactical intelligence network to fuse intelligence information into a common picture. It supports commanders from battalion to EAC with a complete view of their battlespace. Intelligence information acquired by ASAS often includes enemy deployments, capabilities, vulnerabilities, and potential courses of action. ASAS is compatible with other intelligence/surveillance systems such as the Marine Corps IAS, as well as, the Air Force's Rivet Joint and JSTARS. In the future, ASAS will form the intelligence module for ABCS. [Ref. 19: p. 12 and Ref. 40]

2. Air Operations (Air Defense)

The Forward Area Air Defense Command, Control, and Intelligence System (FAADC2I) is the primary C4I system that supports the air defense functional area. By interfacing with other joint or Allied air defense C2 systems and other ground sensors, it collects, processes, and disseminates aerial target recognition, identification and location. The system uses Joint Tactical Information Distribution System (JTIDS) radios to receive long-range air pictures from the Air Force's AWACS. The FAADC2I automatically disseminates this information to Army commanders and Forward Air Area Defense (FAAD) battalions by using SINCGARS or the MSE network. [Ref. 28: p. 27 and Ref. 40]

3. Fire Support

The fire support functional area is supported by the Advanced Field Artillery Tactical Data System (AFATDS). This system automates, processes, and manages fire support data received or transmitted to and from fire direction centers, fire control centers, and other operation facilities from corps to platoon levels. This is performed by using a common suite of hardware components and software applications. Some examples of information passed over AFATDS include up-to-date battlefield information, target analysis, unit status, and coordinate target damage assessment. The AFATDS also provides Army commanders a tool to assist them in determining the right mix of firing platforms and munitions required to defeat high priority enemy targets. [Ref. 28: p. 27 and Ref. 40]

4. Maneuver

The maneuver functional area is supported by the Army's Maneuver Control System (MCS). It is an automated system composed of rugged workstations (terminals) interconnected by coaxial cables into a local LAN or through telephones connected to the MSE network. These terminals allow users to transmit, access, or query battlefield information either locally or from remote locations. MCS terminals are typically located in tactical operations centers at the battalion through corps levels. They support the exchange of near real-time tactical information such as enemy/friendly force locations, warning orders, operation orders, fire support requests, intelligence requests, supply status reports, and air operation requests. The system's graphical displays provide commanders with an up-to-date picture of the battlefield enabling them to optimize, synchronize, and concentrate their combat power. [Ref. 28: p. 27 and Ref. 40]

5. Logistics

The logistics C2 functional area is supported by the Combat Service Support Control System (CSSCS). This system provides automated control of all combat service support activities, by providing commanders the capability to assess the unit's state-of-readiness and model potential courses of action upon receiving updated logistical information. This system interfaces with other C4I systems for in both ATCCS and STACCS. [Ref. 28: p. 27 and Ref. 40]]

C. ARMY COMMUNICATIONS SUPPORT SYSTEMS

The Army's communications support systems provide interconnectivity among the C4I systems supporting users at EAC and ECB. Similar to C4I systems, these communications support systems are also categorized as either theater or tactical systems. The method for categorizing these system was introduced earlier in Chapter II.

1. Theater Communication Support Systems

Theater communications support systems are those systems used at Echelons Above Corps (EAC) to support high level users who normally operate in a theater's communication zone. The Tri-Service Tactical Communication System (TRI-TAC) is the Army's digital secure theater communications support system. It provides connectivity and communications support to the corps Tactical Operation Centers (TOC), major commands, Army component headquarters, and occasionally the JTF headquarters. Collocated at these locations are AN/TTC-39 and AN/TYC-39 circuit and message switches respectively, that allow users direct interface with the TRI-TAC communications network. The network architecture is composed of a series of circuit and message switches arranged in a grid-like pattern. Interconnectivity is achieved by using GMF SATCOM, troposcatter, or

LOS UHF/SHF multichannel microwave systems. Critical network gateways, C2 headquarters/centers, and signal area communications nodes, are often connected with multiple communications links or "dual-homed", as a measure to increase the system's redundancy, reliability, and survivability. The TRI-TAC system services both dedicated subscribers and common users with secure message (up to top secret), data, voice, and facsimile communications. In addition, the system provides seamless interconnectivity to other national, theater, and tactical communication networks such as TRI-TAC networks established by sister military services, MSE networks used at ECB, and other foreign communication networks installed by our NATO allies. Another important attribute of the TRI-TAC system is the capability of its switches to access long-haul DCS communications services such as DMS, DSN, and DDN. This access is achieved through network gateways connected directly to strategically located DCS entry stations. Since TRI-TAC communication equipment is organic to the Army's supporting signal units, they normally have the responsibility for installing, controlling, and maintaining the network. To ensure users are provided with continuous communication service, system mangers closely monitor and control the TRI-TAC network/components by using Communications System Control Elements (CSCE) and Communications Nodal Control Elements (CNCE). While the systems managers use the CSCE for managing and controlling the overall network, they use the CNCE for managing individual local signal node centers. [Ref. 6: p. 7-100 and Ref. 32: p. 6-88]

The ultimate goal of TRI-TAC systems is to support higher level theater commanders with secure, continuous, and reliable communications that not only interfaces with strategic "reach back" systems to the NCA, but also interfaces with tactical systems used by ECB elements. This goal is a prerequisite for the Army to maintain total force control within the theater of operations.

2. Tactical Communication Systems

As stated earlier, the Army Tactical Command and Control System (ATCCS) is the main tactical communication system used by units at Echelons Corps and Below (ECB) typically operating in a theater's combat zone. Communication support within ATCCS consists of Area Common User Systems (ACUS), Army Digital Data Systems (ADDS), and Combat Net Radios (CNR).

a. Area Common User System (ACUS)

Mobile Subscriber Equipment (MSE) is the Army's prominent ACUS of choice for supporting tactical units at ECB. Users of the system can communicate throughout the length and width of the battlefield in either a mobile or static situation. This relatively new system replaced earlier generations of equipment that could no longer meet the Army's needs. The system covers the entire corps area, from its rear boundary all the way forward to the maneuver battalion rear area. A typical corps sized area network will cover 37,000 square kilometers and provide secure digital service for 8500 wireline subscribers and 1900 mobile subscribers. MSE is a nodal switched system extended by radiotelephone. Its backbone architecture, shown in Figure 14, is formed by Line-of-Site (LOS) microwave links connecting Node Centers (NC) together in a grid-like pattern. Other key elements of the system are Large Extension Nodes (LEN), Small Extension Nodes (SEN), Signal Control Centers (SCC), Radio Access Units (RAU), Mobile Subscriber Radio Terminals (MSRT), and Digital Non-Secure Voice Terminals (DNVT). [Ref. 43]

The architecture supports area common user communications requirements on the fluid and integrated battlefield described in the Army's doctrinal manual, FM 100-5, *Operations*. These requirements include survivability when damaged or overloaded and self-controlling features that allow

the network to compensate for rapidly shifting subscriber locations and densities. The system enhances Command Post (CP) movement by providing selected users with telephone service even during movement. MSE further supports CP dispersion by combining wire and mobile access in the same general area of interest. The system incorporates a number of modern features to include high strategic and tactical mobility, without sacrificing its capabilities or survivability. The system is fully compatible with the majority of existing Army communications systems to include Tri-Service Tactical Communications

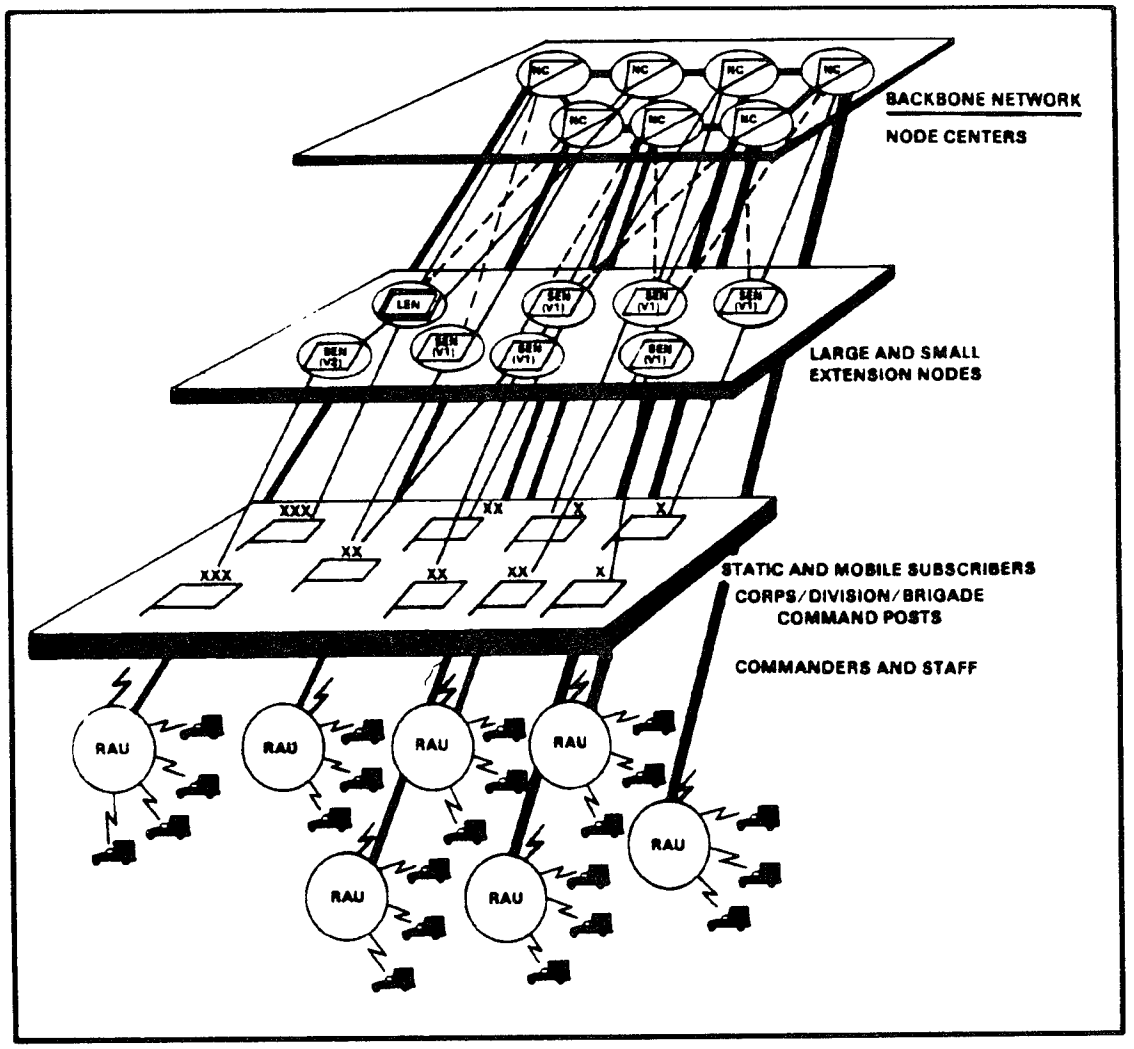

Figure 14. MSE Backbone Architecture. [After Ref. 36]

(TRI-TAC) switches and the AN/TSC-85 or AN/TSC-93 series GMF tactical satellite terminals. These tactical satellite terminals give the commander an essential "long-haul" communications capability which is an absolute "must have" in today's CONUS-centric force projection Army. Figure 14 also shows that mobile subscribers, down to and including maneuver battalions, receive their access into the MSE network through their MSRTs, which are serviced by the Radio Access Units (RAU). The RAU integrates up to eight separate telephone calls into a Digital Trunk Group (DTG) which is then sent to a switchboard by LOS radios. [Ref. 43]

In the future, MSE will undergo two major modifications. The first will be to modify MSE CNR interfaces that will increase the data rate throughput between its packet switch network and SINCGARS. The second involves modifying existing MSE LOS links to extend their range capabilities using the new MILSTAR satellite system. [Ref. 40]

Despite its few limitations, MSE is still considered a combat force multiplier because of its many capabilities. It gives the modern Army force commander a robust and dependable communications system that will enable him to effectively command and control his forces so that he can fight and win on any battlefield.

b. Combat Net Radio

Combat Net Radio (CNR) provides today's Army commanders with a means to exercise their C2 over highly mobile forces. The three primary components that constitute the CNR communications are Very High Frequency (VHF) Frequency Modulated (FM) radios, single channel Ultra High Frequency (UHF) satellite terminals, and High Frequency (HF) radios.

The SINCGARS is a VHF FM radio that provides users, particularly at lower echelons, real-time C2 over maneuver forces during the execution phase of combat operations. This radio is the center piece for the Army's C2 radio networks for frontline units such as artillery, armor, and infantry. The SINCGARS single most important contribution to tactical radio communications is its Electronic Counter Countermeasures (ECCM) capabilities. By using direct sequence spread spectrum and frequency hopping techniques, the radio can provide users secure voice and data communications in a jamming environment. SINCGARS gives the Army and Marine Corps a common, reliable, and adaptive radio system that can be used in vehicles, aircraft, or manpack configurations. Additionally, these radios can interface with the MSE tactical network through CNR interface devices located inside some of the MSE switching shelters. [Ref. 6: p. 7-13]

One of the current limitations with SINCGARS is its low transmission and throughput data rates. To overcome this limitation and other shortfalls, SINCGARS System Improvement Plan (SINCGARS SIP) will upgrade the radio's communication protocols and add a new Global Positioning System (GPS) feature. Protocol modifications will increase the radio's existing capability for SINCGARS to SINCGARS data transmissions when used through the MSE packet switching network. Furthermore, the transmission and throughput data rates will be increased four times that of the current radio. [Ref. 44]

The single channel UHF Satellite Communications (SATCOM) terminals are small, compact, portable radios that extend the range of conventional LOS VHF FM radio communications. These radios are used extensively by light airborne divisions, air assault divisions, special operations forces, and contingency support units to communicate secure voice and data traffic over high priority radio nets. Typical missions that require the use of UHF SATCOM terminals are deep

reconnaissance missions, special operations, and initial phases of force deployment to the theater. [Ref. 6: p. 6-17]

The Army is currently performing operational testing on a new tri-band satellite terminal, that will replace its current UHF SATCOM terminals. The tri-band satellite terminal would operate in the C-, Ku-, and X-band (military) frequency ranges to support T1 (1.544 Mbps) data rate transmissions. With this capability, operators could transmit and receive secure voice, data, and video images. [Ref. 6: p. 6-17]

To fulfill the tactical commander's Army's long range HF radio communication needs, the Army uses the Improved High Frequency Radio (IHFR). This radio is capable of transmitting secure voice and data when used with KY-99 or MD-1230 secure equipment. The IHFR can be configured for use in either a manpack or vehicle application. Like the UHF SATCOM terminal, the radio is particularly effective during deep reconnaissance operations, due to its operating range capabilities of 2500 miles (depending on the specific model). IHFR, however, is more often used as a reliable and redundant back up system for other TRI-TAC, MSE, or UHF radio communications links. This is primarily due to its high power omni-directional transmission signatures that increases chances for detection, thus decreases its survivability. [Ref. 32: p. 5-9 and Ref. 45: pp. 2-29 to 2-33]

c. Army Data Distribution System (ADDS)

The ADDS is a collection of several automated data distribution systems that give commanders a secure means to collect, manage, and disseminate near real-time information regarding the tactical situation. This information often includes unit locations (enemy and friendly), reconnaissance/sensory information, and targeting data. The two systems that make up ADDS are the Joint Tactical

Information System (JTIDS) and the Enhanced Position Location Reporting System (EPLRS).

JTIDS is a secure UHF radio system used primarily at ECB to transmit and receive high-volume, high-speed digital data traffic, such as weapon system alerts, warnings, targeting, and ranging information. This autonomous system is composed of a network of secure UHF radios that transmit message traffic to other terminals by using omni-directional broadcasts. The radios are capable of operating in a hostile jamming environment by using frequency hopping and time-sequence transmission schemes. JTIDS is interoperable with the other services' derivative JTIDS systems, NATO's Multifunction Information Distribution System (MIDS), and other surveillance systems. To extend the system's range, JTIDS is capable of transmitting air defense data received from the Air Force's AWACS or the FAADC2I (common to Army air defense artillery units). JTIDS contributes to the C2 process by improving the tactical commander's situation awareness that is essential to determining proper employment of weapon systems, prioritizing targets, and selecting types of munitions. [Ref. 32: p. 6-50]

Enhanced Position Location Reporting System (EPLRS) is a secure, contention-free, data communications system that tactical commanders and staffs use to report a unit's identification, location, and navigation information. This capability significantly reduces the chances of unfortunate fratricide incidents from occurring on a highly congested battlefield. EPLRS supports the exchange of real-time C2 information by using a geographically dispersed network of secure UHF radio relay links between net control stations and user terminals. Although EPLRS was designed as an autonomous system, it can interface with the Marine Corps' Position Location Reporting System (PLRS) and the Army's Battalion and Below Command and Control System (B2C2) System. Despite a low data rate throughput of 1.2 Kbps, the system enhances maneuver flexibility, fire power

effectiveness, and manpower efficiency of combat forces. It performs this function by assisting commanders determining optimal maneuver passages, corridors, and zones to avoid hostile battlefield obstacles and enemy forces. The 24th Mechanized Infantry Division proved the system's utility and capabilities through its successful use of EPLRS during Desert Shield/Desert Storm. [Ref. 46]

D. SUMMARY

Two principle Army C4I systems that support theater and tactical commanders are STACCS and ATCCS, respectively. The Army's portion of WWMCCS is called AWIS. It provides STACCS with the necessary interface to WWMCCS for implementing JOPES and other joint service systems supporting regional CINCs and the JCS. At the theater level, STACCS offers users at EAC with the capability to perform force tracking, rear operations, and force sustainment throughout the contingency spectrum. Since STACCS uses a standard set of hardware/software components and common operating systems, it can fully interface with ATCCS. The ATCCS architecture is composed of five BFA's, matching the five C2 functional areas used throughout this thesis, and three types of communications support systems. The C4I systems that support each functional area include: ASAS for intelligence, FAADC2I for air operations (air defense), AFATDS for fire support, MCS for maneuver, and CSSCS for logistics. The three types of communications support systems are ACUS, CNR, and ADDS. Common to each type of communications systems is they provide the physical interconnectivity among the Army's C4I systems.

As the size of the Army continues to shrink, due to ongoing force reductions, it is imperative that commanders have the capability to obtain timely and accurate information necessary to fight smarter and more efficiently. To achieve this goal, the Army developed its Enterprise Strategy that guides C4I

system consolidations and other ongoing modernization initiatives. This strategy outlines both an economical and practical approach to capturing the advancing technology being developed by commercial vendors. C4I systems emerging from this strategy such as the ABCS support the long-term goals of the C4IFTW concept and the development of GCCS. Ultimately, ABCS or its derivative systems must support joint interoperability concepts and C2 requirements that are becoming essential to fighting and winning tomorrow's AirLand Battle.

XI. C4I FOR THE WARRIOR CONCEPT

A. INTRODUCTION

The previous four chapters introduced the C4I systems for each of the military services and how they will contribute to the evolving global C4I architecture. This idea of a C4I architecture erupted from studying lessons learned during the U.S. military's involvement in Grenada, Panama, Persian Gulf, Somalia, and Haiti. Common to each of these conflicts was the increasing reliance and use of joint forces to fulfill national, strategic, and military objectives. Lessons learned have clearly pointed out the importance and need for joint C4I interoperability among the services. This need in combination with a shrinking military force, dwindling system procurement budgets, and growing uncertainty of future contingencies have encouraged senior military staffs to pursuit a "new way of doing business". The Command, Control, Communications, and Computers Intelligence For The Warrior (C4IFTW) concept, initially approved by the Secretary of Defense in 1992, encompasses the strategy to accomplish this goal. [Ref. 47: p .2]

The C4I Architecture and Integration Division of the Joint Staff (J6I) introduced the C4IFTW concept, due to numerous problems discovered while the services were attempting to modernize their existing "stovepipe" or service unique C4I systems. Some of the problems encountered were the duplication of C2 functions, incompatibility between systems, increased maintenance costs, increased procurement costs, and limited flexibility. Upgrading stovepipe systems can no longer be viewed as either economically or operationally feasible to compete for constrained budget resources or to support the warfighter's growing C2 requirements. These shortfalls have lead to the development and approval of the C4IFTW concept. There are several key documents and directives that guide

the implementation of the C4IFTW concept such as; the National Military Strategy Document that defines C4I overall program objectives for joint and combined arms across the spectrum of conflicts, DoD Policies 4630.5 and 4630.8 that outline policies for establishing a global C4I infrastructure, and Joint Publications 6-0 and 6-02 that describe requirements for C4I systems to support future joint operations. [Ref. 47: pp. 18-19]

The primary goal of the C4IFTW concept is to support the CINCs and JTF Commanders (warfighters) with fused real-time information that provides them a true representation of their battlespace. This information not only provides warfighters with timely decision aides, but also enhances their ability to coordinate horizontally and vertically with other organizations during the prosecution of their assigned missions. The C4IFTW concept acts as a roadmap for integrating the warfighter's critical functions into a common C4I system by improving interoperability between the services, taking advantage of commercial-off-the-shelf technology, and providing maximum flexibility in joint force composition. Upon completion, the C4IFTW will provide warfighters the information necessary to fight smarter and more efficiently with a smaller joint force.

The three main components of the C4IFTW concept are the warrior's terminal, the warrior's battlespace, and the infosphere. The warrior's terminal is the composition of hardware and software that gives the warrior multimedia connectivity and access to fused battlespace information. These terminals perform a variety of functions to support the warfighters specific C2 requirements including: [Ref. 47 and Ref. 48: p. 8]

- Information storage and sharing
- Artificial intelligence and decision making tools
- Wargaming

- Simulation
- Multi-level security
- Tactical picture displays
- Interoperability and communication support

The warrior's battlespace refers to the area where the warrior exercises control or possesses a military interest. Warriors, operating within their battlespace, require a fused tactical picture that represents the integration of air, sea, and land forces. This dictates that information to be fused into a common operating environment that can be exchanged with other C4I systems. By using approved standards, protocols, and interfaces, interoperability between existing systems is now possible. An example of a CINC'S battlespace is his/her assigned theater of operations. [Ref. 47: p. 9]

The infosphere is a global C4I network that forms a seamless communication architecture. It will provide the warfighter with immediate access to a central repository or "warehouses" of information at anytime and from anywhere. By having access to this information, the warriors can extract only the information needed to make timely decisions. Depending of the commander's desires, the infosphere may automatically update the warrior's local database as the centralized database is changed or altered by other sensors and input systems. [Ref. 47: p. 10]

B. PHASES OF C4IFTW

The C4IFTW concept is an implementation strategy that originally consisted of three phases that included quick fix, midterm, and objective phases. This strategy quickly gained favoritism and support, because it satisfied both the military's near-term and long-range goals for joint C4I interoperability.

1. Quick Fix Phase

The goal of the quick fix phase was to launch the C4IFTW concept into motion by providing immediate and temporary solutions to the warrior. This phase entailed the development and use of system interpreters that translates data from key C4I systems within the military services. The Joint Universal Data Interpreter (JUDI) is an example of a interpreter used to improve interoperability of candidate systems selected for future migration in the midterm and objective phases. JUDI is a software system that fuses tactical displays, interprets various data formats, and formulates messages for output. Additionally, JUDI offered an innovative and economical way to use existing stovepipe systems to achieve short-term interoperability goals. Victory was declared for this phase of the C4IFTW in 1993. [Ref. 47: pp. 15 and 23]

2. Midterm Phase

The primary goal during the midterm phase is to create a global C4I system, commonly referred to as the "system of systems", which continues to prosecute improved interoperability initiatives set forth during the quick fix phase. This global C4I system is called the Global Command and Control System (GCCS). The GCCS is currently being created by migrating the "best of breed" or selected systems supporting the CINCs desirable C2 functions. Some of the candidate systems selected by the services as the best of breed for further migration into GCCS include core subsystems from the Army's STACCS, the Air Force's CTAPS, and the Navy's JMCIS. The criterion used for selecting the best of breed systems were based on how well they support the CINCs desired core functions. A few of these core functions are crisis planning, force deployment, force employment, force status, air operations, fire support, intelligence, personnel, position, and narrative information. Collectively these core functions will support the

warfighter's effort to plan, execute, and manage military operations, in order to, maximize their use of limited defense resources. [Ref. 48: p. 7]

The GCCS supports the general goals of the C4IFTW concept through its capability to generate and deliver fused real-time information to the warfighter during joint and combined operations. Besides the warfighter, GCCS also meets the C2 needs of other users such as the National Command Authority, the Joint Staff, Service Component Headquarters, supporting DOD agencies, and Allied Force Commanders. Since the Defense Information Switching Network (DISN) infrastructure supports GCCS connectivity, all users should be able to exchange valuable information at anytime and from anywhere. [Ref. 49]

GCCS has become the focal point for developing future strategy, policy, doctrine, and system acquisition programs, as the military modernizes its C4I systems. Its construction is based on a C4I modular design and client-server architecture that can be tailored to meet the warfighter's unique C2 requirements. GCCS is basically a hybrid system that consists of a group of customer applications (ie. functional modules), extracted from earlier systems. By having a single consolidated system like GCCS, functional duplication and database inconsistencies will be eliminated. Furthermore, the single system approach supports ongoing efforts toward achieving full interoperability between military service comprising a joint force. After completing the construction of GCCS and successful proof-of-concept for its functions, victory of the midterm phase can be declared. [Ref. 47: pp. 17-23]

3. Objective Phase

The objective phase is the final step required for implementing the C4IFTW concept. During this phase advancing technologies and experience gained from previous phases will be used to continuously optimize evolving C4I systems. The

main goals of the objective phase are to: field a multifunctional, multimedia terminal to the warrior, ensure seamless exchange of information throughout the warrior's battlespace, and provide a global infosphere from which the warrior can pull desired information. Success during the objective phase will greatly depend on imagination, innovation, creativity, and ingenuity by system developers, warfighters, and supporting DoD agencies. [Ref. 47: p. 17]

C. PROOF-OF-CONCEPT

To measure success and progress in implementing the C4IFTW concept, C4I systems such as GCCS must be demonstrated, tested, and evaluated in a joint operational environment. This requires the users to integrate various candidate systems (functions) into their operations so that functional values can be measured. In the past, joint training exercises and real-world deployments have provided excellent opportunities for demonstrating, determining, and identifying the progress and related issues of C4I systems supporting the C4IFTW concept.

The strategy for evaluating functional applications and modules used in GCCS consists of the following three objectives: [Ref. 48: p. 12]

- Selection of candidate systems for future migration into GCCS
- Conducting a proof-of-concept for new functions integrated into GCCS
- Determining user satisfaction by soliciting feedback

Candidate systems are chosen based on how well their contributing functions support the C2 needs of the warfighter during the planning and execution of joint and multinational operations. Once selected as candidate systems, they are integrated into GCCS core functions as modular components. This requires a

series of tests or proof-of-concept to evaluate their attributes such as interoperability with other supporting systems, usefulness of their contributions to the warfighter, and performance reliability in an operational environment. To accomplish this objective, a series of demonstrations are conducted to validate the added components or resolve past issues of concern. Demonstrations normally occur during or immediately following scheduled joint training exercises. Examples of past joint training exercises and demonstrations include the series of Secure Tactical Data Network Tests (1-4), TANDOM THRUST, AGILE PROVIDER, and JWID 94. Specific evaluation goals during these exercises and demonstrations included measuring system interface capabilities with supporting communication networks, testing of GCCS core functions and integrated software packages, and evaluating interoperability between GCCS and other C2 systems used at lower echelons. Other demonstrations have been incorporated, whenever possible, to support real-world missions such as planning and controlling the U.S. force deployment to Haiti. Planned demonstrations, much like the past, will continue to be designed to maximize user participation and solicit feedback. User assessments and input must drive ongoing changes in the development of GCCS to fully support the C2 needs of the modern warfighter. [Ref. 47: p. 21 and Ref. 50: p. 1]

D. SUMMARY

The C4IFTW concept charts the course for modernizing the military's C4I systems. Since its approval in 1992, C4IFTW has gained overwhelming support and momentum by the NCA, joint staffs, CINCs, and other government agencies. It is a modern concept that significantly influences the development of joint strategy, doctrine, training, policies, and acquisition programs. The C4IFTW concept allows the rapid integration of advancing off-the-shelf technologies to

support the modern warfighter during joint and multinational operations. GCCS, being developed as a baseline C4I system, will provide the joint warfighter with the capability to fight smarter with a much smaller force.

The C4IFTW concept originally consisted of three phases which were the quick fix, midterm, and the objective phases. Victory was declared for the quick fix phase after the successful integration of the JUDI. This interface gave the warfighter a limited, but immediate solution to resolve interoperability problems among the service's existing C4I systems. Currently the military services are heavily engaged in meeting the challenge outlined for the midterm phase that requires the development of a global C4I architecture using GCCS. To meet this common objective, each service has developed their own strategy which include the Air Force's Horizon, the Army's Enterprise, the Marine Corps' MAGTF C4I, and the Navy's Copernicas strategies. Collectively, these modernization strategies are paving the way toward reaching the final objective phase for implementing the C4IFTW concept. In the objective phase, the warfighter will be provided the capability to "pull" information, as needed, from a global infosphere and "pushed" or automatically receive selected information updates from consolidated databases.

Since the primary goal of the C4IFTW concept is to support the warfighters, it is imperative they remain actively involved in the development and proof-of-concept demonstrations. Their input and feedback will influence the type of functional design and customer software applications offered by the next generation C4I systems. Although this process is currently underway, it will continue during future joint training exercises and demonstrations such as UNIFIED ENDEAVOR and JWID 95, scheduled later this year.

Current trends indicate that future contingencies will require the application of fully joint forces that have the capability to synchronize their combat power at the right time and place. This will further compel the need for commanders at all

levels to acquire and use fused real-time battlespace information to fight and win tomorrow's wars.

XII. RECOMMENDATIONS FOR FURTHER RESEARCH

The scope of this thesis was limited primarily to C2, C3, and C4I used at the operational and tactical levels of the services. However, this subject area extends to all levels of command to include national, strategic, joint and combined operations, not specifically addressed in this thesis. To provide introductory students in the Joint C4I Curriculum with a comprehensive primer in C2 and other related topics that covers these areas, further research is recommended. Specifically, this research should address national, strategic, joint and combined level C2 organizations, deployment planning systems, roles, decision making processes, and modern C4I technology. Other areas that establish fertile ground for additional research include the following:

- Special operations forces' roles, organizations, C4I systems, and communications support systems
- U.S. Coast Guard roles, organizations, C4I systems, and communications support systems
- National, strategic, and joint contingency planning and C4I systems
- Strategic nuclear C2, organizations, and C4I systems (NORAD)
- Joint Operations Planning System (JOPS)
- Joint Deployment System (JDS)
- Unique joint contingency C4I and communication support systems
- Administrative requirements, organizations, and functions at the national and operational levels
- Defense level planning systems (JOPES, JSPS, PPBS)

- Functional CINCs' roles, organizations, and C4I systems
- National and strategic level sensors and intelligence processing

Advancing technology continues to have a profound effect on today's C4I architectures. Since this thesis is used to educate tomorrow's leaders, system developers, and analyst, it is paramount for this document to remain updated. Further research in C4I and the other areas recommended above will be the means to accomplish this task. Ultimately, this additional research will provide Joint C4I students with the educational tools and technical skills they need to meet their commanders' C2 warfighting requirements.

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